

Interaction of Aeronautical Decision-Making and Organizational Safety-II in the Context of Airline Transport Pilot Training

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To cite this article:

Rodrigo Lima Brugnara, Rejane de Souza Fontes, Donizeti de Andrade, Marcelo Soares Leão. Interaction of Aeronautical Decision-Making and Organizational Safety-II in the Context of Airline Transport Pilot Training. *Education Journal*. Special Issue: *Competency-based Training in Aviation Personnel Training Programs: A New Concept of Training Standards Based on Knowledge, Skills, and Attitudes (KSA)*. Vol. 11, No. 1, 2022, pp. 12-25. doi: 10.11648/j.edu.20221101.12

Received: December 4, 2021; **Accepted:** January 6, 2022; **Published:** January 15, 2022

Abstract: This paper discusses safety issues related to the accident involving a Colgan Air, Inc., Bombardier DHC-8-400, N200WQ, operating as Continental Connection flight 3407 with focus on strategies to prevent flight crew monitoring failures. The issue is to foster the proper training of pilots for better decision making aligned with the organization's safety philosophy as safety capacity. The primary objective of this research is to understand further the synergetic interaction between Aeronautical Decision-Making skills and organizational Safety-II. Although retributive justice has long been accepted in the aviation industry, its effectiveness is refutable. Procedures are static tools incapable of sustaining Safety. Mere improvement in compliance creates a bureaucratic work environment permissible to hold workers against regulations. Applied New Safety concepts and restorative justice are discussed. Whilst safety capacity is detached from work as imagined, the active interaction between people and the rules is at focus. The Colgan Air flight 3407 is analyzed concerning flight crew training. Recommendations derived from the investigator are scrutinized in cross-reference with the Civil Aviation Regulator's outputs in Europe and the United States. A systemic deficiency in civilian pilot training is exposed. The research method is bibliographic and qualitative. As a result, the imminent need to subside cadets with a formal learning structure to enhance their capacity to analyze, create and evaluate outside forecasted protocols in complex, high-risk environments are discussed. Finally, these dynamics are revised at their inter-reliability as safety capacity.

Keywords: Safety Capacity, Aeronautical Decision-Making, Safety-II, Problem-Solving, Training

1. Introduction

Why did the pilots do that? This is a fairly common retrospective view when the focus is aimed at identifying an individual's mishap. The so-called 'human error' is evidenced in an aeronautical occurrence when the desired outcome is misaligned with the result in fact materialized.

In a retributive analysis (post-factum), there is an intrinsic attempt to find the 'broken link' in the chain of events, and therefore to correlate the upset (or unexpected outcome) to an alleged 'human error' in terms of culpability under Safety-I optics.

Karl Weick's insight [30] defines reliability, or simply Safety, as a dynamic non-event.

The traditional parametrization of Safety, herein referred to as Old Safety and Safety-I, provoked modern scholars. However, whilst industry-accepted metrics tend to focus on the absence of accidents, contemporary specialists find it somewhat paradoxical to measure Safety by its absence.

Safety is the ability for workers to be able to do work in a varying and unpredictable world [7].

'Human error' is no more than a label. It is a judgment. It is an attribution that we make, after the fact, about the behavior of other people or about our own [10].

Accidents come from relationships, not broken parts [11].

In 2017, Dekker delineated the contrast and transition between the old view and the new view of 'human error'. The

first one sets 'human error' as a separate category of behavior to be feared and fought. It is the cause of trouble. Efforts target zero errors, zero injuries, and zero accidents as achievable goals. The latter one perceives 'human error' as a symptom of deeper trouble, as attribution, and a judgment made after the fact. The system's improvement lies in enhancing resilience through the people and the organization as a whole.

This work challenges the simplistic linear perspective to an undesirable occurrence in the dynamic and complex aeronautical context. A note of clarification is due to state the reason for reluctance in using the term 'accidents' in this paper. Instead, occurrence was the word of choice, as it carries a neutral and unbiased connotation. The intention is to remove the judgmental aspect when looking at a consolidated scenario in order to preserve impartiality and the opportunity to pose relevant questions.

It is routine for flight crew members to adhere to SOPs (Standard Operating Procedures) and comply with the regulations. However, to those who may feel resentful about being told what to do, the FAA (Federal Aviation Administration) has named 'anti-authority' as one type of hazardous behavior and attempts to drive pilot's attention to regard the rules, regulations, and procedures by the use of this antidote: 'Follow the rules. They are usually right' [28].

Workers leave home and show up for duty with the intention to execute a good job, comply with the regulatory and company directives, and return home safely. If due care is taken and procedural compliance is adequate, why do accidents continue to happen? A typical response is frequently associated with 'human error'. This being the failure to decide assertively or to take adequate and timely corrective actions.

In 2016, the FAA published a profiling chart including five traits of accident-prone pilots. The study suggests that these crews tend to have: disdain toward rules, a high correlation between accidents on their flying records and safety violations on their driving records, and fit a personality category that frequently fall into the 'thrill and adventure-seeking'. In addition, they are impulsive rather than methodical and disciplined, both in their information gathering and the speed and selection of actions to be taken. Lastly, they have a disregard for or tend to underutilize outside sources of information, including copilots, flight attendants, flight service personnel, flight instructors, and ATC.

A retrospective analysis following an upset is often associated with the lack of attention, knowledge, or conformity with what was expected from the crew. Despite its wide acceptance by technical management in the industry, the assignment of blame to the 'defiant' agent turns out to be an immediate retributive tool. Retribution is a prominent constraint to the restoration of Safety as capacity. In accordance with Conklin [7], it's impossible the coexistence of learning opportunities or system improvement and punishment at the same place in time.

Culpability is beyond the scope of this study. Therefore, the classification of error and violation is also set aside. For example, a hypothetical aircraft involved in a CFIT

(controlled flight into terrain) occurrence generates the same prejudice to its occupants if the crew's actions are rooted in a mistake or a violation. Thus, the irrelevance of the causal motive. This analysis emanates from the conception that the individual acts to the best of his knowledge with the available resources at a given time.

In light of that, Air Transport Operators direct efforts to achieve corporate compliance, and its flight deck analog, also known as procedural compliance. A critical analysis is due. In accordance with Cintra [6], human beings are tempted to reason within their own capability, including experience, exposure, technical background, emotions, and more.

As a highly standardized industry, commercial aviation has embraced strict regulations since the ancient Greek history of Dedalus and Icarus in Crete. Rule challenging, but also interpretation drifts have always been present. Paraphrasing Dekker's idea of 2001, there is a persistent notion in aviation that not following procedures can lead to unsafe situations and outcomes and that safety is a direct result of people following guidelines. Evidently, the industry responds with streamlined expectations for the crew. But there is no one size fits all.

Further mature analysis from Dekker [9], in his article 'Follow the Procedure or Survive,' derogates strict compliance from practical safety. He acknowledges the discrepancy between the written procedures and actual practice. The ambiguity is at the impossibility to simultaneously follow the rules and get the job done in a complex dynamic operational environment. Beyond that, a mention to Rochlin, La Porte and Roberts [22] recall that some of the safest complex dynamic aviation systems operations today refrain from using written procedures on some of their most challenging activities.

As rules are rigid, safety assurance is at the capability to interpret regulations in their variability. Based on Klein [18] and Sanne [23], Dekker [9] reminds us that procedures are resources and don't self-dictate coherent application. Decision-making and problem solving regarding appropriate rule application are substantial and skillful cognitive activities that require training. Imminent outcomes to this process are either failure to adapt or adaptation attempts that result in failure. Further to that, he defends that in order to progress in safety, organizations must monitor and understand this variability gap and develop ways to support people's capacitation on decision making and judgment as to how and when to adapt.

If one watches a movie and learns the end of that story, it is relatively simple to picture the sequence of events that took place. Hence, it would not be possible to conjecture against reality all possible dynamics before watching the movie. The same happens in air operations.

Safety is not about having all the answers. It is about having the capacity to ask better questions and, in turn, focus on the actual problem. It demands training, exposure, and practice.

Functional management of context incorporates a compassionate nature and the agent's unbiased view at the

moment in reference. Therefore, this study focuses on 'human performance' (the positive outcome of human management of variabilities) rather than human errors.

Conklin [7] defends that the only thing that stops you from getting the information is thinking you already know it. New Safety is the management of context. The improvement in operational conditions is more effective than the attempt to alter worker behavior. It is essential to grasp this concept to absorb what is discussed here.

In an era when many accidents are attributed to human error, it is fundamental to understand why people do what they do.

This work is centered at the intersection of the flight crew's ADM (Aeronautical Decision-Making) skills, and the actual Safety-II implemented in the operational environment. The interest lies in the synergetic interaction between the two pillars depicted in Figure 1.

The overlap represents Safety Capacity in the management of context through the optics of human performance. In other words, the scope is at the systemic ability or potential 'to do' Safety, fail safely, and adaptive capacity as a result of the aforementioned interaction.

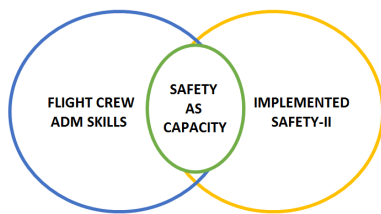


Figure 1. Intersection between Organizational Safety-II and Flight Crew ADM Skills as Safety Capacity.

1.1. Objective

The main objective of this study is to analyze how the ADM training within the Part 141 ATPL training program in its overlap with the organization's actual implementation of the New Safety can sum and generate a synergetic moment in the form of safety as capacity, through the optics of human performance.

1.2. Hypothesis

The construct uses the hypothesis that it is possible to enhance safety as capacity by the early stimulation and development of civilian cadet's ADM skills within the existing training structure of an integrated or modular ATPL (Airline Transport Pilot License) Course of an ATO (Air Training Organization).

1.3. Research Question

Therefore, the research question is: Is it possible to enhance safety as capacity by developing ADM skills for cadets undergoing ATPL indoctrination courses?

1.4. Methodology

The research methodology is predominantly bibliographic

and qualitative. It encompasses the analysis of best international practices in the modern commercial aviation industry published by credible stakeholders, associations, and product manufacturers. In addition to that, a cross-referenced investigation between the herein referenced key Civil Aviation Regulators and Civil Aviation Investigators majorly in the Americas and Europe is also present. The human performance considerations are carved from a critical comparison between the literature of recognized scholars in the Americas, Europe, and Oceania.

1.5. Byproduct

The expected byproduct is the proposition of a preliminary Organizational Safety Capacity Assessment Card to be a practical tool for cadet pilots undergoing training and possibly during their initial employment.

1.6. Justification and Relevance

The aim is to be able to identify in a neutral and independent manner the level of maturity of actual safety capacity observed at the operational environment the crew is engaged in operations. Indications are irrespective of any documented ATO or AOC (Air Operator Certificate) holder approved manuals and free of third-party biased opinions. This is relevant because the reality of practical operations doesn't necessarily match the CAA (Civil Aviation Authority) accepted manuals (work as imagined). In other words, real work practice is commonly different from the written guidance.

1.7. Benefit

The proposed benefit resides in the independence and crew empowerment advantage. This tangible tool serves as a situational awareness instrument for the pilot and the organization by directing attention to the broader safety-relevant aspects of the organizational environment rather than as a flight risk assessment device. Additionally, it assists the cadet to ask better questions and possibly generate a momentum of change towards a positive safety culture for pilots of all grades of experience.

2. The Safety Scholar's Perspective

This section identifies the contrast between different schools: Safety-I and Safety-II through cross-examination of the high-level specialist's observation.

Retributive justice distances from what safety as a dynamic non-event should be in a just culture environment [30]. This unconformity aligned with the industry-accepted retributive safety system is the reason why this study is born. When Safety is referenced by the absence of errors and accidents, the onset of a misleading referential point appears. The investigation parameters tend to be vicious to the fragile link, which is usually one or more human beings.

The idea of punishing or exonerating a specific agent who failed to comply with the regulation or procedure portrays

itself as an ideal swift solution for managers. By doing so, it's possible to remove the 'defective' non-compliant link. Heinrich [14] determined in the pyramid below that by preventing accidents, the injuries will 'take care of themselves' (Figure 2). Zero accident equals to zero injuries.

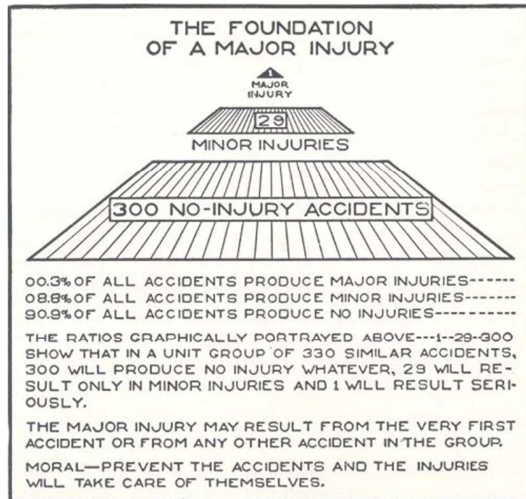


Figure 2. The Foundation of a Major Injury 1-29-300 (adapted from [14]).

The foundation of a major injury. The 300 accidents shown in the lower block are not merely unsafe practices. They are falls or other accidents which resulted in narrow escapes from injury.

This retrospective is refutable. Contemporary safety scholars have shifted the attention from the reason processes 'go wrong' to why they actually succeed most of the time. The human being is the key factor for successful operations and is no longer the weak link. Thus paradoxically, safety has been measured by its absence. The sensitive change is now learning from what is actually functional.

Reducing a problem to a false simplicity by ignoring complicating factors is defined as simplism [25]. Complicating factors are analogous to the complex dynamic of real-life interactions an individual faces when conducting every flight. Standard operational procedures and quality control and assurance have played an essential role in their integration with Safety.

The enforcement of procedural adherence causes the line of commercial air transport undesirable occurrence statistics ('accidents') to assume the shape of an asymptote over time. Asymptote is a straight line associated with a curve such that as a point moves along an infinite branch of the curve, the distance from the point to the line approaches zero and the slope of the curve at the point approaches the slope of the line [3]. In other words, the line of occurrences in time approaches zero but never touches zero (Figure 3).

When zero accident is the main objective, simplifying is not the answer. Targeting the reduction of safety occurrences to a single cause, namely human error, is an open dismissal of growth and learning opportunities.

... simply writing off ... accidents merely to (human) error is an overly simplistic, if not naive, approach...

... After all, it is well established that accidents cannot be

attributed to a single cause, or in most instances, even a single individual [24].

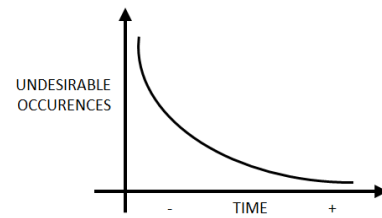


Figure 3. Non-dimensional Asymptotic Line Representative of Undesirable Occurrences vs. Time.

The increase in the number of regulations and procedures isn't capable of bringing the line of undesirable occurrences over time to zero.

Any commercial enterprise has profit at the heart of its reason to exist to accommodate a healthy lifespan and allow possible growth. Therefore, the onset of an occurrence causal of property damage or health injuries is directly opposed to the core goal of any business venture. Hence, this is why safety exists in the commercial environment.

Safety is the means to sustain the operation as a whole, as its deficiency impairs business continuity, public credibility, and profitability. The means to achieve is the pathway, the journey, not the final point.

Conklin [7] defends that a desirable operation, safety-wise, will have safety as high as it needs to be to remain profitable and as low as it needs to be to avoid property damages and health injuries, and death.

Quantifying adverse events such as 'accidents' is simpler than measuring the number of times a procedure was omitted or completed in a substandard manner by the flight crew without further prejudice to the successful completion of the mission.

Ideally, consequences of the deviation are contained by the system without catastrophically compromising the mission (fail with resiliency). However, it is natural to focus on the negatives. Reason [21] states that accidents are salient, and normalcy is not.

Safety-I scholars like Heinrich measured safety by the absence of accidents. Events that have already happened can be relatively easily translated into tangible metrics, charts, and graphs. While the understanding of past events might appear as an opportunity to learn, at this point, the prejudice or harm have already taken place.

In 2000, Barnett and Wang [4] prepared a research report under the National Center of Excellence in Aviation Operations Research. This MIT (Massachusetts Institute of Technology) study reveals that passengers are less prone to die in an airplane operated by a carrier with a higher number of reported hazards. The principle is opposed to the earlier dogmas and is grounded on the presence of factual data as a resource rather than a problem.

Enlightened by that, the retrospective segment of the line is set aside to perceive the benefits of acting proactively at the management of context. Undesirable occurrences 'happen' at the management of context (Figure 4).

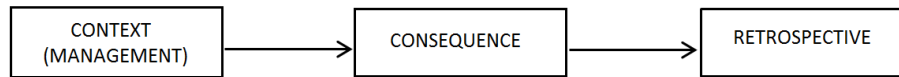


Figure 4. Parts of an Event (based on [7]).

It is evident that the operational outcome comprising human deviations most often ends up with a safe completion and opportunities to learn. Erroring is intrinsic to human nature.

Despite the fear of reprehension from the authority or management, or even an enhanced focus and alert to perform a given task, errors will still occur. One flight operation is never identical to the previous one, even when the crew, routing, time of the day, and aircraft remain the same. The interest here is to understand how to amplify safety as a capacity at the management of context rather than in a retrospective fashion.

It is indeed a rather counter-intuitive idea to desire a high volume of safety events in an organization when aiming for capacity. The motivation of this study lies in the transition from the abstruse of safety theorization to the provision of a tangible assessment tool (card) to aid the cadet undergoing

training.

Whilst grasping the historical concepts of safety and its definitions remains relevant, young cadets must be empowered with enough knowledge to independently conduct a practical safety capacity assessment of the system in which (s)he is engaged in, to consciously deliberate the risk exposure (s)he wills to accept. This learning exposure has to be triggered at the initial stages of flight instruction.

Despite the best training manuals, indoctrination programs, and state-of-the-art equipment, accidents still happen and will continue happening in the future. Figure 5 depicts a gap between the work as imagined (the idealistic condition of a perfect world as described in the manuals, shown as the black line) and the work as it actually happens in real life (blue lines). Whilst good companies design the work as imagined based on the work as reality, there will always be a tradeoff.



Figure 5. Work as Imagined versus Real Work (based on [29]).

This tradeoff is known as the management of variability [7]. It comprises the grey area of uncertain interpretation, in which the onset of a complex set of events was naturally not depicted in the manuals. Still, despite that, the crew has to act upon it.

Commercial aviation (excluding general aviation) is an ultra-safe high-risk industry with less than one disastrous accident per ten million events [8]. This statistic demonstrates that most of the time, the decisions facilitate a restoring moment from the real work towards work as imagined, which is a desirable outcome.

When the real work suffers a single failure and is able to

remain functional, it has capacity for resilience, and the operation as a whole is not interrupted. When the real work (blue line) touches the hazard line (red line), the catastrophe occurs (yellow star). Refer to Figure 5.

Since most of the time in the commercial aviation industry, the decisions are taken within the grey area to define a safe outcome and a singular dynamic interaction of variables, it's of fundamental relevance to understand the management of context rather than the retrospective of an undesirable occurrence. Table 1 depicts the human performance impacts on safety capacity.

Table 1. Human Performance Impact on Safety Capacity (based on [7]).

Human Performance Impact on Safety Capacity Based on Conklin's Constructs			
Area	Scenario	Potential to Increase Safety Capacity	
Human Performance	Absence of negatives	Low	
Human Performance	Presence of capability		High
Safety Indicators	Low historical metrics of undesirable occurrences & reports	Low	
Safety Indicators	High number of hazard reports		High
Management of Change	Management of accidents (post-factum)	Low	
Management of Change	Management of context (focused on operational conditions)		High
Management of Change	Hold worker against the work as imagined line (retribution)	Low	
Management of Change	Swift and appropriate response to workers discomfort		High

As we pointed out in 1994, human error is just a label. It is an attribution, something that people say about the

presumed cause of something after the fact. It is not a well-defined category of human performance that we can

count, tabulate and eliminate. Attributing errors to the actions of some person, team, or organization is fundamentally a social psychological process, not an

objective, technical one [31].

Vanguardist safety scholars are interested in human relationships rather than resources.

Table 2. Fact Sheet: Bombardier DHC-8-400, N200WQ Occurrence (based on NTSB/AAR-10/01).

Aircraft Model	Bombardier DHC-8-400 (Dash 8 Q400) – MTOM 29,257kg Registration: N200WQ
Flight	Date: the 12th of February, 2009 Number: CJC3407 Codeshare: Continental Airlines (Continental Connection)
Route	From: Newark Liberty International Airport, Newark, New Jersey To: Buffalo Niagara International Airport, Buffalo, New York
NTSB Record	NTSB/AAR-10/01 Total: 49 (49 fatalities)
Occupants	Passengers: 45. Crew: 4 (1 PIC, 1 SIC, and 2 Cabin Crew) Ground injuries: 1 (fatal) and 4 (non-fatal) PIC: Male, 47 years old (3,379 TFT, 111 TTOT) Background: previously SIC on Beech 1900 Important considerations: failed on FAA initial IR in 1991, CPL SE in 2004, and ATPL in 2007. Partial pass on Saab FO operator checks in 2006, and failures on recurrent exams in 2006 and upgrade in 2007
Flight Crew (2)	Reported peer's perspective on PIC: methodical and competent SIC: Female, 24 years old (2,244 TFT, 774 TTOT) Background: flight instructor - piston fixed-wing aircraft Reported peer's perspective on SIC: average to above-average to her experience level Normal operations until the approach phase
Summary of Flight Dynamics (Last moments)	Arrival airport with light snow, visibility 4,800mts, and ceiling at 2,700ft VREF set for uncontaminated aircraft At 3NM from the outer marker, airspeed is 184kt (max is 138kt). The captain sets Flap 5°, condition lever Max Rpm, reduces throttle close to Flight Idle, and extends the landing gear. The unnoticed onset of stall, accompanied by visual (on the PFD), aural, and tactical (stick shaker) cues indicate the loss of situational awareness A sequence of inappropriate corrections took place, leading to an upset and eventually the catastrophe. Summary: stall warning onset, pitch up at 14 degrees angle of attack with 125kts, then rolling left 45 degrees, rolling to the right, airspeed reduction to 100kts with flap retraction, 105 degrees bank to the right and descending, left roll at 35 degrees bank, landing gear retraction, and 25 degrees pitch down at 100 degrees bank angle
Factual Remarks	The crew selected "INCR" (increase) associated with the "REF SPEEDS" on the anti-ice panel whilst the on ground in Newark The system output for this action is the activation of the stick-shaker at a lower angle of attack due to the possible ice accretion on the wings In turn, the initial stall warning indication on the final approach was unrealistic. The aircraft was not close to a stall at that moment
Probable Cause	Inappropriate response to stick shaker activation by the PIC and subsequent aerodynamic stall (not recovered)
Contributing Factors	Failure to select, monitor, and manage airspeed during approach in icing conditions. Failure to manage flight and adhere to sterile cockpit PIC: commuting to Newark from Tampa SIC: commuting to Newark from Seattle
Considerations on Fatigue	CVR recordings prior to takeoff captured the SIC's remarks on physical discomforts, such as sinus pressure, sneezing, and sniffing. NTSB discussion is inconclusive to set fatigue as a contributing factor
Recommendations to the FAA	In the capacity of the investigator body, NTSB concluded the investigation with forty-six findings and four main probable causes. A twenty-five items recommendation list was issued to the FAA
Regulatory Impact	Led to the creation of the Airline Safety and Federal Aviation Administration Extension Act of 2010 ATP: Airline Transport Pilot License CPL: Commercial Pilot License CVR: Cockpit Voice Recorder IR: instrument rating PIC: Pilot in Command
Glossary	SE: Single Engine SIC: Second in Command TFT: Total flight time in hours TTOT: Total time on type in hours



(a)



(b)



(c)

Figure 6. NTSB.

2.1. Aviation Stakeholders – Same Goal, Different Approaches

2.1.1. The Investigator's Perspective

This section discusses the Civil Aviation Investigator's perspective against the Civil Aviation Regulator's view in light of the Colgan Air flight 3407 final investigation report. Beyond a brief review of this occurrence depicted in Table 2, the intention is to pave the ground to understand the regulatory implications derived from the lessons learned.

Amongst the twenty-five recommendations issued by the

NTSB (National Transportation Safety Board) to the FAA, a broad range of disciplines were evidenced. Those related to flight operational quality assurance programs, flight and duties, rest, fatigue management, weather reporting, use of personal portable electronic devices on the flight deck, and others are acknowledged and valued [19, 20].

For the scope of this paper, four strategies limited to pilot professionalism, pilot training, regulatory oversight, and qualification requirements were selected for further analysis. Table 3 depicts an overview of their content.

Table 3. NTSB Recommendations to the FAA: Bombardier DHC-8-400, N200WQ Occurrence Based on NTSB/AAR-10/01.

Number	Applicability & Action
A-10-13	Applicable to: 14 CFR (Code of Federal Regulations) Part 121, 135, and 91K operators Action: issue an advisory circular guidance on leadership training for upgrading captains, including methods and techniques for effective leadership; professional standards of conduct; strategies for briefing and debriefing; reinforcement and correction skills; and other knowledge, skills, and abilities that are critical for air carrier operations
A-10-14	Applicable to: 14 CFR Part 121, 135, and 91K operators Action: require all operators to provide a specific course on leadership training to their upgrading captains that is consistent with the advisory circular requested in Safety Recommendation A-10-13
A-10-22	Applicable to: 14 CFR Part 121, 135, and 91K operators and 14 Code of Federal Regulations Part 142 training centers Action: require the aforementioned to develop and conduct training that incorporates stalls that are fully developed; are unexpected; involve autopilot disengagement, and include airplane-specific features
A-10-26	Applicable to: 14 CFR Part 121 135, and 91K operators Action: develop more stringent standards for surveillance of those operators experiencing rapid growth, increased complexity of operations, accidents and/or incidents, or other changes that warrant increased oversight...

The investigator's preoccupation with the quality of flight crew training in terms of knowledge, skills, and attitude becomes evident. Moreover, a stringent regulatory oversight is recommended targeting those operators experiencing rapid expansion in size or complexity for possible compromises in the organizational management of change.

In other words, the interaction between sustainable and structured organizational growth in terms of corporate safety, as well as the flight crew's capability to assertively perform time-critical decision-making processes in a dynamic and unique complex environment, have the potential to generate safety as capacity, or it's a reduction to unacceptable levels. This is the central point of Figure 1 and this article.

2.1.2. The Regulator's Perspective

Triggered by the family members of the Colgan Air 3407 victims, a lobbyist effort favored the U.S. Congress's opportunity to sanction, followed by the former President Obama's signature into law of the Airline Safety and Federal Aviation Administration Extension Act of 2010 [26]. Title II – Airline Safety and Pilot Training Improvement incorporate industry advancements such as the rulemaking proceedings to establish mandatory implantation of Flight Operations Quality Assurance Programs and Safety Management Systems for FAA CFR Part 121 operators. While these two programs have a profound impact on Safety as Capacity, this paper is solely interested in the training strategies discussed herein.

Section 206 discusses Flight Crew Mentoring, Professional Development, and Leadership. Section 208 follows, with concerns to the Implementation of NTSB Flight Crewmember Training Recommendations. Altogether, they address mentoring, development, initial and recurrent qualifications within CFR Part 121 operators (airliners). Section 209's interest is on the FAA Rulemaking on Training Programs.

Section 217 (Airline Transport Pilot Certification) demands the FAA to conduct a rulemaking proceeding to alter the 14 CFR Part 61 regarding the issuance of ATP certificates and consider the Part 135 and 121 expert's assessment and recommendations. The proposed requirement sets the minimum of 1,500 flight hours and a sequence of associated sub-items to be satisfied to enable a pilot to operate in an airline environment. Attention is drawn to authority's preoccupation to derive mechanisms to ensure the crewmember's effective capability to perform in multi-crew operations, multi-engine aircraft, high-altitude, adverse weather and in a high-standardized context.

Aligned with the lessons learned with the Colgan Air flight 3407 and analog occurrences, this sub-chapter discusses the regulatory impacts of the FAA AC 61-138 [27] and EASA (European Union Aviation Safety Agency) ED Decision 2018/001/R [13]. The first publication alters the ATP licensing requirements within Title 14 of the Code of Federal Regulations (14 CFR) part 61, § 61, whilst the latter introduces the KSA Learning Objectives 100 within the EASA oversight under Part FCL (Flight Crew

Licensing). Both efforts are directed to provide better preparation; thus, a smoother transition from a commercial pilot license holder to the airline environment through base knowledge and practical exposition in a modern FSTD (Flight Simulation Training Device) mentored by an airline instructor.

The AC 61-138 provides guidance and information to training providers and system users regarding the FAA counterpart's implementation, approval, structure, and contents. These documented manifests corroborate the need to change perceived by the Civil Aviation Regulator and the Civil Aviation Accident Investigator linked to the ADM pillar of Figure 1.

In 2014, EASA identified that 50% of the newly qualified pilots holding a CPL, frozen ATPL, theoretical exams, ME/IR (Multi-Engine and Instrument Rating), and a standard

MCC (Multi-Crew Cooperation course) fail at European operator initial assessments. The sample was 3,500 candidates.

A First Officer engaged in a 14 CFR Part 121 operation (airline under FAA) requires an FAA ATP license, therefore 1,500 hours (and satisfaction of associated minima) to act as SIC. In the EASA environment, this requirement doesn't exist, but there are other provisions.

Would this generate a safety prejudice to European carriers? Once again, there is no simple answer. Different problems require different medicines. In other words, a tradeoff exists. A linear comparison is not possible because what works in North America might not be ideal for Europe and vice-versa. Table 4 below depicts a comparative chart between the expected training pathways for an ATP cadet under FAA and EASA.

Table 4. Comparative Chart: FAA 14 CFR Part 141 ATP vs. EASA Part FCL ATPL Integrated Training.

	FAA	EASA
ATO Certification	14 CFR Part 141 NAA approval of training curriculum, syllabus, and lesson plans Continuous NAA oversight	EASA Part FCL – Integrated NAA approval of training curriculum, syllabus, and lesson plans Continuous NAA oversight
Structure	Rigid; full-time dedication Provides training reduction benefits to Part 61 providers Pass mark is 70%. Total of four exams: Private Pilot license (#60) Commercial Pilot license (#100) Instrument rating (#60) Airline Transport Pilot license (#125)	Rigid; full-time dedication Provides training reduction benefits to Modular programs Pass mark is 75%. Total of fourteen exams: Principles of flight (#44) Air law and ATC procedures (#44) Operational Procedures (#45) Human Performance & limitations (#48) VFR Communications (#24) IRF Communications (#24) Flight Performance (#35) General Navigation (#60) Flight Planning and Monitoring (#43) Aircraft General Knowledge (#80) Instrumentation (#60) Radio Navigation (#66) Mass and Balance (#25) Meteorology (#84)
NAA Exams & Number of Questions (#)	Total: 345 Questions (12hrs exam) Min. 35 hours to PPL (40hrs in Part 61) Min. 190 hours to CPL (250hrs Part 61) PPL (Private Pilot License) NR (Night Rating) ELP * (English Language Proficiency)	Total: 682 Questions (18:15hrs exam) ~ 150-200 hours in the aircraft * ~ 40-80 hours in the simulator (FNPT-II) * PPL * (Private Pilot License) NR (Night Rating) Complex & High Performance CPL (Commercial Pilot License) IR (Instrument Rating) PBN (Performance Based Navigation) MEP (Multi-Engine Piston) ELP (English Language Proficiency) MCC (Multi Crew-Cooperation) APS-MCC** optional (Airline Ready MCC) JOC** optional (Jet Orientation Course) A-UPRT (Advanced Upset Prevention & Recovery Training) Frozen ATPL (14 subject pass) CPL, ME, IR, PBN, ELP 4+, MCC, JOC** & A-UPRT
Practical Flying	Min. 35 hours to PPL (40hrs in Part 61) Min. 190 hours to CPL (250hrs Part 61) PPL (Private Pilot License) NR (Night Rating) ELP * (English Language Proficiency)	~ 150-200 hours in the aircraft * ~ 40-80 hours in the simulator (FNPT-II) * PPL * (Private Pilot License) NR (Night Rating) Complex & High Performance CPL (Commercial Pilot License) IR (Instrument Rating) PBN (Performance Based Navigation) MEP (Multi-Engine Piston) ELP (English Language Proficiency) MCC (Multi Crew-Cooperation) APS-MCC** optional (Airline Ready MCC) JOC** optional (Jet Orientation Course) A-UPRT (Advanced Upset Prevention & Recovery Training) Frozen ATPL (14 subject pass) CPL, ME, IR, PBN, ELP 4+, MCC, JOC** & A-UPRT
Modules (milestones)	Complex & High Performance CPL (Commercial Pilot License) IR (Instrument Rating) ME (Multi-Engine)	Complex & High Performance CPL (Commercial Pilot License) IR (Instrument Rating) PBN (Performance Based Navigation) MEP (Multi-Engine Piston) ELP (English Language Proficiency) MCC (Multi Crew-Cooperation) APS-MCC** optional (Airline Ready MCC) JOC** optional (Jet Orientation Course) A-UPRT (Advanced Upset Prevention & Recovery Training) Frozen ATPL (14 subject pass) CPL, ME, IR, PBN, ELP 4+, MCC, JOC** & A-UPRT
Advanced Training	ATP CTP (Airline Transport Pilot Certification Training Program)	ATP CTP (Airline Transport Pilot Certification Training Program)
First Airline Placement:	Full ATP license (unfrozen)	Full ATP license (unfrozen)
Minimum Experience	1,500 hours	No minimum flying hours
Glossary	NAA: National Aviation Authority ** Required by several operators, but optional to the NAA	* Variable

A note of clarification is due to register the indirect relationship between the level of proficiency in terms of

flying hours or quality of the experience. Civil Aviation Regulators determine the minimum practical experience

required for a flight handling examination towards an initial license. Despite that, sole reliance on the number of flying hours has proven to be a parameter not solid enough to determine the preparedness and possession of an adequate skill set for a given flight crew prior to its operational assignment. It highlights the upcoming need to move from prescription-based to competence-based qualification.

The American regulator opted for a higher operational experience (in flying hours) prior to allowing a first officer to work in the capacity of SIC. As previously explained, this regulatory mark finds its origin at the Colgan Air 3407. Today's minimum experience is 1,500 flying hours.

Through analysis, EASA opted for a different pathway. The European system carries a certain degree of traditionalism by stressing a profound theoretical foundation for its pilots. Cadets opting for this route are required to complete a minimum of 850 hours of formal ground school through a CAA approved ATO. This training covers ~15-18.000 exercises in preparation for the NAA exam sittings, in addition to the classes. ATOs are also required to confirm cadet's readiness for the CAA exams through recorded school mock exams prior to the issuance of student's authorization to

sit for official NAA exams.

On the practical side, a series of advanced training was added to the European cadet's curricula, as shown in Table 4. A fine-tuning is required in an attempt to balance technical knowledge with practical experience. A European airliner can be served with a 200 hour SIC pilot, whilst an American vessel counts on a 1,500 SIC pilot. Which operation is safer?

While there is no precise answer for this question, a decisive pilot's quality leading to a direct impact on Safety has been identified and deemed special treatment. It's the Aeronautical Decision-Making skills in practical problem-solving.

In order to address this gap, the ICAO Doc 9995 (Manual of Evidence-Based Training) [16] was used as guidance to develop the EASA KSA 100 (KSA: knowledge, skills, and attitudes) and its associated learning objectives (LO 100 01, 02, 03 and 04, depicted in Table 5) for CPL, ATPL, and MPL (Multi-Crew Pilot License) applicants. This requirement is mandatory from the 31st of January, 2022, as published on the EASA Executive Decision 2018/001/R [13]. It aims to develop the student pilot's capability to think critically upon evaluation of variable circumstances.

Table 5. EASA KSA 100 Learning Objectives - Knowledge, Skills & Attitudes.

EASA KSA 100 Learning Objectives - Knowledge, Skills & Attitudes		
100 01	ICAO (International Civil Aviation Organization) Core Competencies	
	Communication	
100 02	Leadership and teamwork	Situation Awareness
	Problem-solving & decision-making	Workload Management
100 03	Threat & Error Management Application of Knowledge	
	Upset Recovery Training & Resilience	
100 04	Mental mathematics (approximations)	

The sensitive change is the transition from passive to active learning. This is the European Civil Aviation Regulator's perspective associated with the Aeronautical Decision-Making pillar of Figure 1. One EASA European Industry Questionnaire received 97.3% feedback corroborating the industry's desire to develop trainee's KSA capabilities since the first day of training.

The ATO conducts KSA 100 assessments. They are related to all technical knowledge disciplines and preferably set in a scenario-based environment. Thus, it has a supplementary character to the fourteen written examinations conducted by the NAA.

Performance is determined by the number of times the competency behaviors have been observed during the exercise. The indicators are: how well, how often, and how many. Grading ranges from one (very good) to five (very poor).

The Guidance Material for Instructor and Evaluation Training published by IATA in 2021 introduces relevant information for the development of training programs by ATOs [17].

Learning objectives (LOs) are textual descriptions of what the student is expected to have acquired upon completion of a given training. Effectiveness and validations of LOs are measured against the practical relevance with current

technologies and methodologies, applicability in context, depth of knowledge, and adequacy of assessment mechanisms.

The clarity aspect of each module is relevant for all stakeholders. Satisfactory LOs delineate precisely what is expected from the student, allowing adequate preparation, and reducing frustration. Transparency also serves as guidance for instructors and training providers seeking consistent delivery.

Unlike the other technical knowledge subjects, KSA 100's applicability is permeated and merged into all subjects throughout the training since day one. In practical terms, the indoctrination mindset shifts from the remembering level (being able to list, describe and recall) upwards to interpretation, evaluation, planning, and creation.

According to Huit [15]; in 1948, a group of educators began works on classifying educational goals and objectives. The idea was to develop a classification system for three domains: cognitive, affective, and psychomotor. In 1956, the work by Bloom, Englehart, Furst, Hill, & Krathwohl was known as Bloom's Taxonomy of the Cognitive Domain [5]. Anderson, Krathwohl and Airasian [1] refined this theory, steering towards the requirements of modern education. The EASA KSA 100 sits on the works discussed in this paragraph as graphically represented in Figure 7.

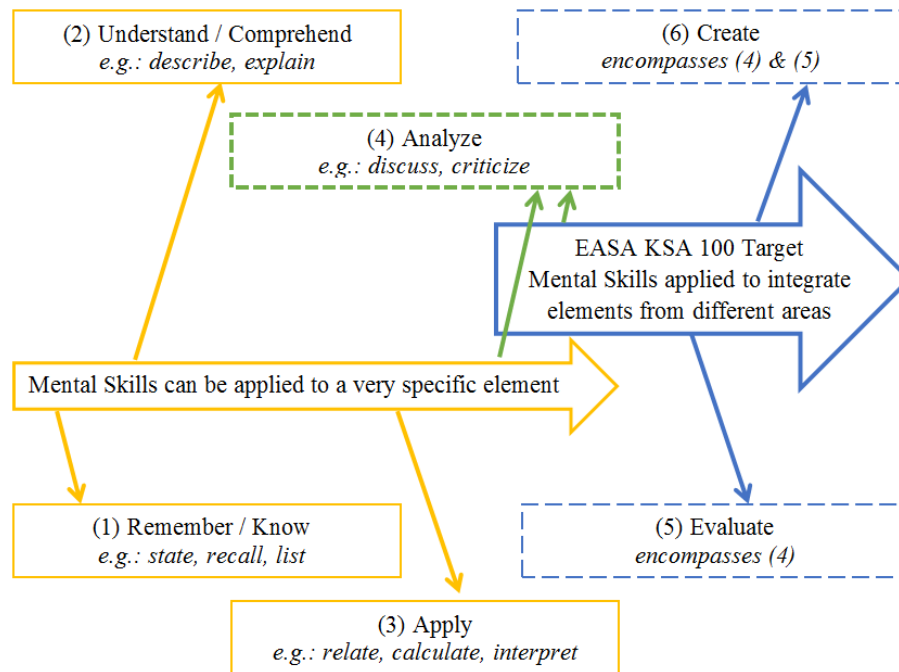


Figure 7. Bloom's Taxonomy of the Cognitive Domain in KSA 100 (based on [1]).

In light of this, EASA has mandated the ATOs to revise their training programs and expects continuous compliance regarding the incorporation of Area 100 KSA. In addition, the Agency envisions a tangible enhancement of key competencies by the pilots (capacity to analyze, evaluate and create).

By granting formal regulatory guidance, the Authority forces training providers to introduce teaching mechanisms to assist cadets in improving aeronautical decision-making skills and problem-solving capabilities.

Contextualizing, The National Civil Aviation Agency of Brazil (ANAC) defines competency-based training as the method focused on what the student must be able to do, rather than the old fashion method based on what the student needs to learn [2].

Whilst regulatory marks have come into effect in Europe and North America, there is no published guidance for implementing mandatory MCC, APS-MCC (Airline Pilot Standards Multi-Crew Cooperation course), or KSA LOs for the commercial pilots granted initial licenses within the scope of ANAC. In addition to that, currently, there is no specific certification oversight for the MCC, JOC, and APS-MCC courses under this regulator (although an oversight exists for the ATO as a service provider).

2.2. Methods

The primary virtue of this research is to further understand the synergy between the two pillars: Aeronautical Decision-Making skills and organizational Safety-II actually implemented on the field. The study lies in the intersection of the two aforementioned pillars and their potential to generate Safety as Capacity. The work is centered on providing practical guidance on corporate safety maturity assessment

for a pilot with incipient operational exposure.

The research method selected is predominantly bibliographic and qualitative. In addition to the author's practical exposure to some of the processes discussed, grounds for this study are mainly possible by the use of the following resources:

1. Safety Scholar's Articles and books in the fields of human factors, error, just culture, and risk management;
2. Field reports and Aviation Accident Reports obtained from the NTSB;
3. US Laws obtained from the U.S. Congress;
4. EU Laws obtained from EASA;
5. Explanation notes obtained from EASA;
6. Regulatory framework obtained from EASA, FAA, and ANAC;
7. Training implantation guidance obtained from IFALPA and IATA;
8. Aircraft information obtained from the manufacturer and NTSB;
9. Advisory Circulars obtained from FAA;
10. General literature in the fields of education, cognitive domain, and psychology;

A historical comparison of Safety, causality, culpability, just culture, retributive justice and restoration is drawn based on the safety scholar's work.

The case study on the Colgan Air 3407 occurrence is based on the investigator's publications and manufacturer's information.

Regulatory implications derived from the aeronautical investigation are studied via regulatory cross-examination amongst the aforementioned regulators. Considerations on the field of education and psychology are carved mainly from

articles published by reputable scholars, for instance Huitt [15], Dekker [9, 11, 12] and Conklin [7].

2.3. Results

This study began with the hypothesis that organizational Safety Capacity could be enhanced by developing ADM skills for cadets undergoing ATPL course. The investigation was centered on the inter-reliability between the crew's ADM skill and implemented Safety-II.

To better understand this synergetic region, a breakdown in areas of study is proposed.

A comparison is drawn between what has been historically accepted in terms of safety management in aviation and what the current industry pioneers believe in. The main takeaway is the vanguardist comprehension that the human being is a safety capacity resource and not a faulty component in the system. Therefore, attention is directed to the functional aspects of the processes and resources rather than the substandard ones.

Safety parametrization is discussed as to the bias of measuring a resource by its absence. Beyond that, retributive justice is identified as a hazard. Whilst restorative justice builds trust and transparency; retribution causes inhibition and system distrust.

Aiming to construct a practical analysis, the discrepancy between the work as described in the regulatory framework and its actual completion in the field is highlighted (work as imagined vs. real work). The critic here lies in the bureaucratization of processes and a heavy focus on compliance. Practical Safety is then dissociated from strict adherence to protocols.

Procedures are now understood as static resources, unable to dictate self-application. At this point, the human capacity to analyze, evaluate and create is essential. Despite the state-of-the-art technology deployed in aviation, critical analysis and cognitive capability to timely decide to adapt are not yet matched by any machine.

Whereas the improvement of any skills is linked to the cognitive processes of learning and repetition (practice), Aeronautical Decision-Making Skills and Problem Solving are substantial and skillful cognitive activities and require training.

Accidents such as the Colgan Air 3407 provoked the Civil Aviation Investigator's interest in flight crew training objectives associated with these two fields. Through formal means, the Civil Aviation Regulator was compelled to act upon the instructional framework for cadet pilots and propose solid guidance to address the flight crew's capabilities in the areas of knowledge, skills, and attitude.

2.4. Discussion - Preliminary Safety Capacity Assessment Card

Streamlined with the EASA [13] propositions and the NTSB's concern of 2010, this study identified a lack of knowledge associated with young cadets' practical exposure to risk.

A dynamic, complex, high-risk operation shall not be

steered based on empiricism or blind adherence to static procedures without assessing due applicability. An adequacy evaluation prior to rule application is necessary [12]. The practical consequence of conducting an operation 'based on the best guess' is a perfect recipe for catastrophe. KSA competencies are vital to any flight crew [1].

The reality is that a young pilot (or instructor) will encounter countless doubts and unanswered questions when pursuing further practical experience. In the management of variability, this is an obvious hazard [7].

It would take great courage and character for a freshly graduated pilot, with only a few hundred hours of experience, a family to support, and 75,000 € training debt, to voice up concerns to a higher rank pilot, or director of operations, and refrain from engaging in an operation with unnecessary risks associated. In many instances, that increased risk exposure might even pass unnoticed to the young crew.

Beyond limited experience, pilots are trained to believe in the system and rules. Yet, controversially, the system design is made by fallible humans. In some operations, the pilot might not even have someone knowledgeable to ask regarding an impending risk or uncertain procedure or organization. Many 'fun rides' take place in this gap. Some end well; others don't.

A conflict of interest is natural. Individually, the pilot's primary concern should be the safe conduction of the operations. In other words, keeping himself, the crew, and consequently the passengers and people on the ground alive. On the other hand, a commercial enterprise has profitability at its heart. The commonality lies in the interest of a successful operation, this being the absence of injuries, loss of life, and material damage.

The threat is: successful operations don't necessarily mean adequately managed risk exposure. For example, a pilot might choose uplift fuel that is only enough for the flight from departure to destination and another five extra minutes of reserve. Despite the violation aspect, it's a common practice in that operator. All colleagues have been doing the same procedure for years, and it has never failed. There are pilots in the company holding that tradition for more than ten years, and they certainly make sure new pilots fit that legacy. The company owner is also satisfied. The fuel consumption is lower than the competitors because no 'dead weight' is being flown (extra fuel). All pilots see that as normalcy until the catastrophe's day.

In accordance with Conklin [7], 'accidents happen in the management of variability.' However, practical operations significantly dissociate from approved manuals, procedures, best industry practices, and even the law. This asymmetry leads to unsafe exposure. The herein proposition is an independent tool to assist civilian pilots in understanding the actual risks in the practical environment of operations.

This preliminary assessment card (Table 6) is neither a replacement nor a substitute for pre-flight risk assessments, manufacturer directives, regulatory guidance, quality tools, or any approved materials. Instead, this aid has the sole purpose of stimulating the pilot to regard routine events that have potential implications in risk exposure that might not be

of common interest or knowledge. Therefore, it is deemed as an informational surprise reduction asset.

Table 6. Preliminary Organizational Safety Capacity Assessment Card Card.

PRELIMINARY ORGANIZATIONAL SAFETY CAPACITY ASSESSMENT CARD		ISSUED ON: 19/AUG/2021 REVISION: ORIGINAL
Instructions: Grade each statement honestly. Assign Yes (✓), No (✗), or N/A, as appropriate. Questions marked 'No (✗)' shall be further investigated using the flowchart below		
MANAGEMENT () There are NO requests to conduct marginal ops, to violate or assume unnecessary risks. If there are, the crew feel at EASE canceling the operation () High management is at the forefront of Just Culture. People are comfortable voicing safety concerns and genuine mistakes () The organization ONLY engages in missions listed in the approved Operational Specifications (e.g., instructional, MEDEVAC, charter...) () Assigned crew/acft are authorized, trained and current to engage in the mission () Key postholders (or safety staff) are trained and open to receive safety concerns () There are NO financial constraints increasing risk exposure (lack of resources)	TRAINING & LEADERSHIP () Staff is duly qualified to exercise their functions. Juniors are assigned senior mentors () Ramp staff are formally trained and prepared to deal with a ground emergency () Captains (or flight crew) undergo a structured leadership training () Company induction is clear and thorough. I truly understand my duties & responsibilities () I've been undergone a FORMAL screening, including license verification, physical fitness, technical knowledge, and practical flying aptitude () Flight renewals are NOT a simple formality. They are used as learning opportunities () VFR flight into IMC is forbidden () Non-approved IFR procedures ('jungle Jepp' & 'napkin approaches') are FORBIDDEN	
SAFETY () The staff truly understand the importance of Safety. It's not taken for granted () When I voice a reasonable safety concern, the colleagues are NOT at unease () Safety is treated as a priority. Unnecessary risk-taking is not tolerated () Reports are treated with due professionalism and seriousness. Feedback is assertive and time-effective. The system allows confidential submissions () The reporting system is simple and easily accessible to ALL staff () Pilots are at ease, FREE from external pressure to decide in the interest of Safety	ORGANIZATIONAL STRUCTURE () There is commonly a synergetic atmosphere in the flight deck (multi-crew ops) () There is no organizational power distance precluding staff from raising safety concerns () NO pressure is exerted on the flight crew following a diversion or extra fuel uplifting () The policy for initial, recurrent, remedial, and upgrade training is fair and CLEAR	
FATIGUE () Flight and duty regulations are duly observed. There is a functional and responsive fatigue reporting system available () I'm not requested to exceed duty times beyond the regulations. If it happens, I'm at EASE to refrain from doing so. There is no retaliation	FLIGHT DISPATCH () Flight pack depicts the mission's reality. It is a resource rather than a bureaucratic task () Flight watch staff are qualified and ready to assist at every mission. I can count on them	
	MAINTENANCE () Aircraft defects are registered in the technical log. Informal reporting is NOT accepted () Pilots FORMALLY record all defects, and maintenance clear or defer timely	
	EMERGENCY RESPONSE (ER) () I'm aware of my duties and responsibilities upon activation of the ER plan	

2.5. Constraints

Safety as Capacity within the academic environment, therefore, remains incipient of studies. A constraint in the availability of pragmatic and less abstruse theorization dedicated to base training was encountered during this project. Several reputable industry references stress the airline's needs in terms of human resources and relationships. However, only a fraction of those publications considers the gap to bridge between the non-airline pilot with a diverse background in their transition to a modern automated flight deck, highly standardized operation, and its associated challenges.

3. Conclusion

Research question: Is it possible to enhance safety as

capacity by developing ADM skills for cadets undergoing ATPL indoctrination courses?

Whereas retrospective justice has offered limited help in preventing new undesirable aeronautical occurrences, restoration favors a system based on trust. Limited to the scope of operational Safety, assigning culpability to 'transgressors' was found to be inefficient.

Real work is done by real people, and errors are simply intrinsic to the species in nature. The same humans involved in operational mishaps are the ones who got the job done safely a more significant number of times.

Organizational Safety-II is heavily dependent on the management-led culture. Better decision-making and more effective problem-solving skills have a direct impact on safety as capacity. An adaptive environment, where workers are treated fairly, with transparency, and rules are molded towards the actual job on the field, is conducive to more

assertive decisions and improvement. Beyond that, less bureaucracy increases people's consciousness of what is important and improves satisfaction in the workplace.

On the other hand, the cognitive capabilities required to complete successful decision-making processes have to be exercised, like any other skill. Regulators began to address this need by focusing on pilot's knowledge, skills, and attitudes right from the first day of flight school.

3.1. Response to the Research Question

Yes. It is possible to enhance safety as capacity by the synergetic inter-reliability between the implemented organizational Safety-II pillar and the systemic instructional stimulation of Area KSA, which is oriented to strengthen ADM skills. As pillars, both are required to be solid enough to sustain safety at the desired level of capacity.

3.2. Further Research

Further research and experimentation are required to enhance the development of instructional mechanisms to empower low-experienced flight crew with the desired knowledge, skills, and attitudes to conduct an independent and realistic risk assessment. Such studies could investigate forms to increase situational awareness and reduce non-deliberate unnecessary risk exposure in real-life operations. Clarification is demanded to separate safety as a capacity beyond the static and per times unreasonableness rigidity of manuals and approximate a final outcome to critical thinking.

3.3. Main Takeaway

Whereas civilian cadets may choose a multitude of career pathways, real-life operations frequently differ from the statutory terms. Whilst airliners tend to be closely adjusted to the industry's best practices; this is not an integral reality. Unnecessary loss of life is irrefutable by the statistics. It's the industry's and Civil Aviation Authority's moral obligation as a whole to ensure that civilian pilots are ready to independently identify imminent organizational hazards that can jeopardize life from the first day on the job.

It is no longer acceptable to approve manuals and consider the job done. Real work differs from written publications. There are air operators worldwide lacking financial resources, adequate structure, appropriate experience, quality maintenance, and definitely functional safety and quality guidance. Unexperienced and seasoned pilots have engaged in substandard operations and paid the limited capacity to identify hazards with their own life. It's time for the industry to take action and pilots to learn when and why to say: No.

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