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Journal of Aviation/Aerospace Education & Research

Volume 31 | Number 2 Article 4

2022

SMS for Part 135 Commuter and On-Demand Operations - The Practitioner’s Perspective

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Scholarly Commons Citation

Ott, M., Carufe, A., & Lu, C. (2022). SMS for Part 135 Commuter and On-Demand Operations - The Practitioner’s Perspective. *Journal of Aviation/Aerospace Education & Research, 31*(2). DOI: https://doi.org/10.15394/jaaer.2022.1934

Introduction

During a trip for Trans-Pacific Air Charters, a 14 CFR § 135 (Part 135) operator, N452DA was flying from Philadelphia International Airport (PHL) to Teterboro (TEB), New Jersey, under Part 91 as a positioning flight with no passengers on board. For this specific flight—the crew's third of the day—the pilot in command (PIC), filed a flight plan for a 28-minute flight at a cruising altitude of flight level (FL) 270 and a cruise speed of 441 knots true airspeed (KTAS). The PIC assigned the second in command (SIC) responsibility as pilot flying (PF), contrary to the company's prohibition of that role for pilots at the SIC's level of qualification (National Transportation Safety Board [NTSB], 2019).

The NTSB (2019, pp. 1-7) accident report indicated that the straight-line distance from PHL to TEB was about 80 nautical miles (NM), but the flight plan indicated a less direct route. Soon after takeoff at approximately 1500 (all times given in local time), air traffic control (ATC) cleared the aircraft on a different, shorter route and limited the aircraft to an altitude of 4,000 feet above Mean Sea Level (MSL). At 1509, ATC issued temporary vectors away from the revised route for traffic sequencing. The aircraft exceeded the Part 91.117 airspeed limitation of 250 knots indicated airspeed (KIAS) below 10,000 feet MSL. Cockpit dialog also indicated a complacent attitude from the pilots. About 10 minutes into the flight, the crew checked in with New York approach, and the approach controller provided vectors for the TEB ILS RWY 06 approach, circle-to-land runway 01.

Forty-eight nautical miles from TEB, the PIC commented to the SIC that they were hundreds of miles from TEB. Less than a minute later, the controller instructed the crew to descend to 3,000 feet MSL to intercept the localizer for runway 06. While attempting to join the localizer, the SIC mistakenly identified Newark International Airport (EWR) as TEB and told the

PIC that he had the runway in sight. The crew flew across the localizer course, and a short time later, the controller noted this error. The crew then followed the controller's instructions to correct their course, turning left to intercept the TEB localizer and flying toward the VINGS waypoint (NTSB, 2019).

While N452DA flew inbound to VINGS, the SIC tried to transfer the controls to the PIC, but the PIC did not respond, and the SIC continued to fly the approach. About 08 miles prior to VINGS, the approach controller cleared N452DA for the approach. Contrary to company policy, the pilots had not conducted an approach briefing, and instead, the PIC chose to coach the SIC through the speed and altitude requirements for the approach (NTSB, 2019).

At 1526 the approach controller instructed the crew to do three things: contact TEB tower, cross the next waypoint DANDY at 1,500 feet MSL, and initiate the circling maneuver at the final approach fix TORBY located 3.8 miles from runway 06. The flight crew acknowledged these instructions but neglected to do all three. The PIC had become so preoccupied with coaching the SIC through the approach that both pilots lost situational awareness. The crew did not contact TEB tower; they crossed DANDY at 2,000 feet MSL and did not begin the circling maneuver at TORBY. About two minutes later, ATC again instructed the N452DA crew to contact the tower, and the PIC continued to coach the SIC, instructing him to descend to the circling minimum of 760 feet. When the crew did establish contact with TEB tower, the controller cleared the aircraft to land on runway 01. When N452DA was about one nautical mile from the approach end of runway 06, the tower asked the aircraft if they were going to start the turn. N452DA banked hard to the right, and while the airplane was in the right turn, the SIC turned the controls over to the PIC. The PIC took the controls, directed the SIC to watch the airspeed, and began a left turn to runway 01 at a high bank angle. During the turn, the SIC called

DOI: https://doi.org/10.15394/jaaer.2022.1934

airspeed four times; the PIC called out the stall, and the SIC agreed, repeating airspeed twice more. Less than 30 seconds later, the aircraft impacted the ground in an industrial area just south of the airport.

Final NSTB Accident Report

In its final report, the NSTB (2019) found the probable cause as the PIC's attempt to salvage an un-stabilized visual approach, which resulted in an aerodynamic stall at a low altitude. The NTSB concluded that the PIC's focus on the visual maneuver of aligning the airplane with the landing runway distracted him from multiple indications of decreasing stall margin. Despite the SIC call-outs, the PIC did not add power or reduce the aircraft's angle of attack during the left turn. Further, the PIC's decision to allow an unapproved SIC to act as pilot flying, the PIC's inadequate and incomplete preflight planning, and the flight crew's lack of an approach briefing contributed to the outcome.

The NTSB's (2019) citation of ineffective or non-existent company safety programs among its final contributing causes resulted from an extensive analysis of the company's existing policies and practices. The existing policy did not include measures necessary to make the company aware of deviations or issues associated with this crew. Beyond the initial identification of these issues and the resulting categorization of each pilot, this policy contained no measures to provide surveillance of or updates on the performance of the lower category pilots. The company also had no check airmen qualified on the Learjet 35 and depended on the Federal Aviation Administration (FAA) to administer line check flights. This practice prevented the effective monitoring of regulatory and SOP compliance by company pilots.

Furthermore, the company's crew resource management (CRM) training did not address SOP compliance or the "influence of planning, briefing, and decision-making on workload and time management" (NTSB, 2019, p.49), issues of particular importance during the accident flight. The CRM program addressed the responsibilities of a PIC as a team leader only in the most general terms. The NTSB also identified that the PIC had never received any leadership training before his designation as a PIC.

The company's director of operations served as the safety officer and acted on the informal safety information that he received, including performance deficiencies reported by the training provider regarding both the PIC and SIC. This awareness, however, did not prevent the assignment of these two pilots to fly together, as an effective progressive qualification policy might have. The company indicated that it had initiated the implementation of an SMS at the time of the accident but still had not done so two years later (NTSB, 2019, pp. 44-51).

Risk Management Analysis – A Case Review

Assignment of Flight Crew Duties to Non-proficient Crewmembers

For most of the flight, the PIC did not maintain sufficient oversight of the crew and aircraft operation. Instructing the SIC in basic flying of the airplane resulted in inattention to his Pilot Monitoring (PM) duties, leading to multiple regulatory and procedural deviations, as well as numerous missed radio calls. To summarize, the PIC's decision to allow the SIC to act as PF placed both pilots in roles they did not routinely perform and for which neither prepared adequately. Thus, neither performed their assigned duties competently during the flight (NTSB, 2019).

Situational Awareness

The PIC seemed to lack overall awareness of the flight environment in his preflight planning and his in-flight assessments. By filing for a cruise altitude of FL270 and later stating that the aircraft was "hundreds of miles from [TEB]," he demonstrated that he did not understand

DOI: https://doi.org/10.15394/jaaer.2022.1934

that the flight would only cover approximately 80 NM. Given that typical ATC practice would require the aircraft to be at 3,000 feet MSL about ten nautical miles and three minutes before landing, the available distance to climb from takeoff to FL270 and back to 3,000 feet MSL would have been only 70-80 NM, flown in approximately 24 minutes. The climb and descent tables available to the crew indicated that this combined climb and descent would have required 80.7 NM and 13.7 minutes (computed for a typical aircraft takeoff weight of 15,000 pounds at standard pressures and temperatures) (FlightSafety International, 2011, pp. 23, 54), as well as integration of the accident aircraft into the traffic arriving and departing from TEB and the other airports in the vicinity.

Latent Factors

Operations in such congested airspace, while in visual meteorological conditions (VMC), would require the crew to anticipate rapid changes of frequency, multiple changes of routing, numerous other radio transmissions, both for their aircraft and others, which the crew should have tracked to maintain necessary levels of situational awareness, and a constant visual scan outside the aircraft for other traffic. The 28-minute flight would require the crew to perform its standard checklists and procedures more rapidly than normal, even while dealing with the issues associated with the congested airspace, creating a demanding operating environment for even an experienced professional crew (NTSB, 2019).

Such demands placed an even greater premium on both preflight preparation and the assignment of suitable duties to each crew member. During a longer flight, the crew would have had time to prepare for the arrival and approach in the later stages of cruise flight, after collecting weather, arrival, and approach information for the destination. In the absence of adequate preflight planning, time pressure exaggerated the crew's already high workload and precluded any such in-flight preparation. The resulting disorientation proved fatal (NTSB, 2019).

Internal Supervision vs. Organizational Culture

At the most critical level, an effective safety program would have established a safety culture--including reporting, just, informed, and learning cultures (Lu et al., 2011)--that identified many of the hazards that the crew encountered and mitigated the associated risks. While absent from the NTSB (2019) report's conclusions, Lu (2021) noted in a discussion of the Hawthorne Effect that company management would have created a significant impediment to the safety culture in its assignment of the director of operations as the safety manager. Doing so impeded an independent assessment of the safety issues associated with their operations. This senior manager's supervisory responsibilities over the pilot workforce would also have had a chilling effect on his subordinates' independent or anonymous safety reporting. This salient conflict of interest contributed to a failure to account for the weaknesses of the PIC that other Trans-Pacific pilots noted in interviews after the accident (NTSB, 2019, p. 9). An influential reporting culture would have revealed these known hazards and led to effective mitigations of the associated risks.

FAA SMS Policy

The FAA's Part 121 Air Service Providers SMS mandate listed a compliance deadline of March 2018 (Safety Management Systems, 2015); therefore, 2019 provided the first year to compare Part 121 safety statistics with mandatory SMS against Part 135 Air Taxi safety statistics without a mandatory requirement. The statistical analysis from the NTSB's 2019 national database (NTSB, 2020) did not differentiate between Part 135 operators utilizing an effective SMS from those operators who did not. As of October 2021, fewer than 155 of the 1,940 Part

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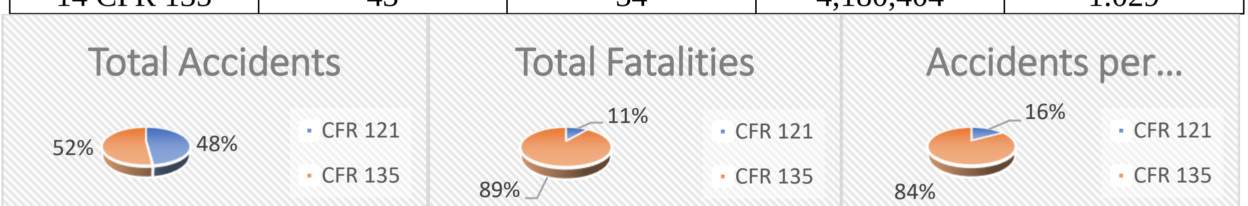
135 operators, less than eight percent, had implemented an audited SMS (International Business Aviation Council [IBAC], 2021b; Air Charter Safety Foundation, 2021; FAA, 2021; NTSB, 2021), which would render this distinction as statistically insignificant.

On the other hand, Part 121 carriers logged roughly four and half times more flight hours than Part 135 operators; thus, we focused on the accidents and fatalities rate (one hundred thousand hours and departures data) in Table 1 for a common neutralized data comparison showing Part 135 encountered an accident rate more than five times the accident rate for Part 121 operators (NTSB, 2020).

Table 1

2019 NTSB Accident Statistics: Accidents per 100,000 Flight Hours

US air carrier operating rules	Accidents	Fatalities	Flight Hours	Accidents per 100,000 Flight Hours
14 CFR 121	40	4	19,786,547	0.202
14 CFR 135	43	34	4,180,404	1.029



Note. Table based on data derived from "Summary of U.S. Civil Aviation Accidents for Calendar Year 2019" by NTSB, 2020.

The NTSB's statistic indicating the higher accident rate created the illusion that Part 135 operators were five times more likely to have an accident, necessitating a deeper review of the total number of departures. Since taxi, takeoff, and landing have statistically proven the most dangerous phases of a flight, comparing flight hours, the predominant portion of which Part 121 operators spend in cruise flight (Boeing, 2012), did not render a complete comparison. To enhance the data analysis, we also compared the total number of departures between Part 121 and Part 135. Unfortunately, the NTSB only recorded the total number of departures for Part 135 commuter operations and omitted Part 135 on-demand departures, which might have misled the readers. However, even though the NTSB did not record some Part 135 (on-demand air taxi) operations, the Table 2 data remained strong, showing accident rates of Part 121 and Part 135 service providers. This data indicated Part 135 commuter operators had approximately seven times more accidents in 2019 than Part 121 carriers (NTSB, 2020). This analysis simultaneously highlighted a safety gap that the NTSB and FAA have been seeking to close.

Table 2

2019 NTSB Accident Statistics: Accidents per 100,000 Departures

U.S. air carrier operating rules	Accidents	Fatalities	Departures	Accidents per 100,000 Departures
14 CFR 121	40	4	19,786,547	0.202
14 CFR 135 (Commuter Only)	9	2	632,793	1.422

Note. Table based on data derived from "Summary of U.S. Civil Aviation Accidents for Calendar Year 2019" by NTSB, 2020.

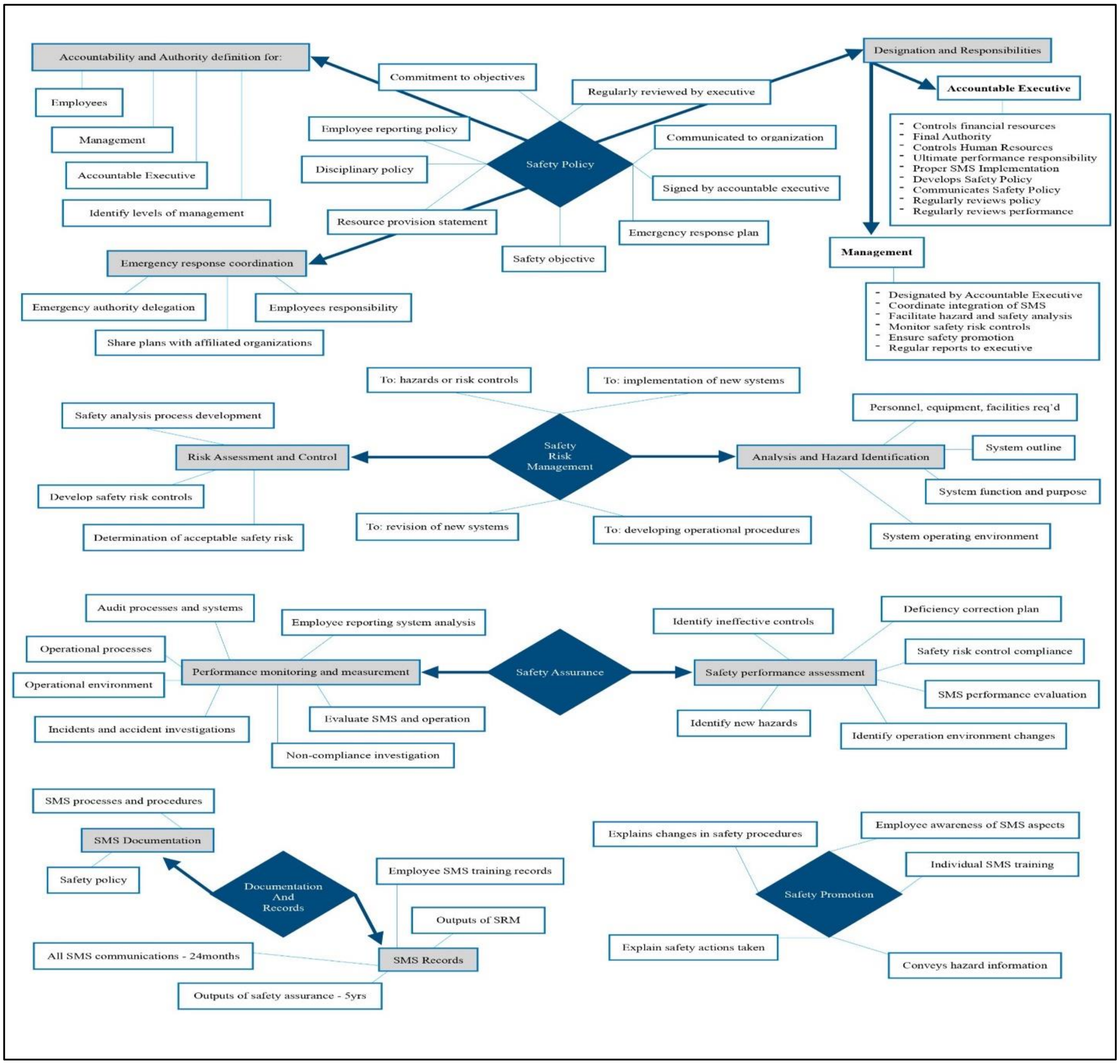
DOI: https://doi.org/10.15394/jaaer.2022.1934

FAA Advisory Circular 120-92B

On January 8, 2015, the FAA published Advisory Circular120-92B, which required air operations under Part 121 to adhere to 14 CFR § 5 (Part 5) SMS requirements (FAA, 2015). The deadline to comply with this regulation was March 2018. The FAA Safety Team broke Part 5 down into six subparts which outlined the FAA's expectations of a compliant airline SMS as shown in Figure 1.

Figure 1

14 CFR Chapter I Subchapter A Part 5 – An SMS Visual Aid



Note. Derived from "AC 120-92B SMS for aviation service providers" by FAA, 2015, and "Safety management system: Voluntary implementation of SMS for non-Part 121 operators, MROs, and training organizations" by FAA, n.d.

Even in this abbreviated depiction, the complexity and nearly unreadable fine print in Figure 1 reflects the overall complexity and difficulty in understanding the information itself, as well as the overall difficulty in implementing an SMS complying with this guidance.

14 CFR Part 5 Chapter I, Subchapter A, § 5.3 (a) (14 C.F.R. § 5, 2015) stated, “The SMS must be appropriate to the size, scope, and complexity of the certificate holder’s operation.” The number of safety professionals needed to develop and maintain an SMS was, therefore, dependent on the size of the operation. The organization had to identify an accountable executive, with responsibilities outlined in Part 5.25(a). The accountable executive would then identify the safety team and place that group within the organizational hierarchy. They would work within Part 5 requirements to design, implement, and maintain an SMS.

Benefits of Safety Management System Implementation

In addition to the availability of free, voluntary FAA programs for both SMS and data participation, United States Aircraft Insurance Group (USAIG, 2021) and Global Aerospace (2021) offer a policyholder dividend equaling up to 15% and 10.6% of the premium, respectively. The greatest benefits, however, would not be financial. As noted by the International Business Aviation Council (IBAC, 2021a), an effective SMS would offer enhanced operational safety, methods for measuring safety performance, improved operational performance, improved stakeholder confidence, and improved teamwork, as well as enhanced pride among the company’s employees.

SMS Deficiency for Part 135 Service Providers

However, statements from the National Business Aviation Association (NBAA, 2021), interviews with safety auditors (A. Ferraro and R. Little, personal communications, 2020-2021) who are experienced with both FAA and International Civil Aviation Organization (ICAO) standards, an industry study (de Wolf, 2021), and at least one Part 135 accident case study (Ott, 2021) have found Part 5 unscalable for most Part 135 operators and incompatible with the ICAO Annex 19 standard required in most international airspace. This observation has yielded a need for a more effective safety program based on existing deficiencies affecting Part 135 air carriers. This study therefore used N452DA Learjet 35 accident as an example to identify upstream contributing factors, to reflect on unsuccessful policy and compliance, and to provide comments for improvement.

Methodology - Risk Management Tools

We applied two-tier analysis including Fishbone Ishikawa Analysis and Fault Tree Analysis (FTA) to conduct a thorough analysis of the selected accident case. A follow-up process aimed at the critical items of SMS could be beneficial to Part 135 operators by reducing potential operator-related risk and improving a company's safety culture. That said, an advanced systemic analysis would help discover upstream causal factors beyond the NTSB's probable causes including organizational issues that could either lead the crew to act in the unsafe manner or permit pilots' weak situational awareness, placing themselves in mortal peril during the perceive-process-performance "3Ps" cognitive process.

Ishikawa Fishbone Analysis

As the first step in accident analysis, the Fishbone Ishikawa Analysis allowed the research team to see an array of all inputs to the outcome. Brainstorming activities following SHELL, 5Ms, or HFACS would later shape a visual fishbone diagram indicating root causes of the undesired event. This effort provided the foundation for the subsequent use of another analytic tool to determine the accident's root cause (Ishikawa, 1990).

Fault Tree Analysis

Researchers used Fault Tree Analysis (FTA) to determine the root causes and probability of occurrences derived from a specific undesired event. FTA proves helpful when evaluating large, complex, and dynamic systems to understand problems better and to implement mitigation strategies (Ericson, 2005). Through its graphic depiction of the relationships between component failures within an overall system (Lu, 2021), FTA proved most useful in the team's analysis of the N452DA accident, even without knowing the mathematical values associated with the probability of each subordinate failure. Given a choice between a deductive approach, which listed the possible causes of a system failure as a means for discovering the potential system failures, or an inductive approach, which began with an undesired outcome and retraced the causal losses throughout the system, the team chose the inductive approach (Vincoli, 2014). If, however, one had applied the deductive approach before the accident, a frank appraisal of the circumstances would have led the team to an accident as the likely outcome.

Validity and Reliability of Analysis

Reliability indicated the capacity of a test or report to "perform in the future as it has in the past" (Lu, 2020). Effective reliability would have meant that multiple renditions of a study resulted in the same outcome. While the minimum method error (tool selection) and trait error (researcher conditions) yielded the maximum reliability, a triangulation process helped ensure analytical consistency. We applied the inter-rater technique to demonstrate reliability (Goff, 2005). For validity, we found convergence among multiple sources of information to form themes or categories in the study. The adoption of triangulation methods when conducting research eliminated the bias of each researcher (Creswell & Miller, 2000).

Research Questions

Q1. What factors contributed to the N452DA Learjet crash in 2017, according to Ishikawa Fishbone and Fault Tree Analysis?

Research Hypothesis: Beyond the NTSB's probable causes of the accident, upstream contributing factors led to N452DA Learjet crash.

Q2. What mechanisms of Safety Management Systems could FAA FAR Part 135 Air Taxi service providers use to mitigate similar risks?

Research Hypothesis: Budget-constrained FAA FAR Part 135 Air Taxi service providers have practical and effective SMS options.

Findings & Discussion

What factors contributed to the N452DA Learjet crash in 2017, according to Ishikawa Fishbone and Fault Tree Analysis?

The information in the NTSB (2019) report of the accident investigation portrayed a relatively straightforward accident scenario. Two pilots acting in unfamiliar roles with limited or no competence attempted to operate a high-performance business jet in the country's most congested airspace. They lost situational awareness and failed to recognize the imminent low-altitude loss of control until recovery was no longer possible. The report, however, alluded to an unsafe operating environment involving hazardous attitudes (FAA, 2016, pp. 2-5) within the company, although the FAA did little to support and protect these employees or the company itself.

Ishikawa Fishbone Analysis & Fault Tree Analysis

After several rounds of group discussion, the researchers narrowed down into several categories for analysis: critical flight phases (preflight, enroute, and approach), management, environment, and technical capability were considered. In the Fishbone Ishikawa Analysis, each branch represented a different area of the flight with one or more apparent failures. Group discussion and triangulation also revealed contributing causes of each selected factor. Please see Appendix A.

The FTA diagram in Figure 2 used two branches: PIC and SIC. The cut-sets included [SIC's violation of SOPs, Weak PIC airmanship, lack of inflight briefing, inexperienced SIC], [SIC's violation of SOPs, Weak PIC airmanship, lack of preflight, inexperienced SIC], [SIC's violation of SOPs, Weak PIC airmanship, the unwillingness of obtaining information, inexperienced SIC] regardless of the failure probability associated with each root cause. (Full-size diagrams are available in Appendixes A and B.)

Hazardous Attitudes

On the FTA's left-hand branch, five primary tree initiators contributed to the PIC's distraction involving Anti-Authority, Impulsivity, and Macho attitudes. All five events pointed to a poor safety culture within the company's flight department. First and foremost, the first officer performed PF duties for all but the last thirty seconds. Not only was the SIC less experienced, but his participation as PF exhibited a blatant disregard for company policy. The NTSB's (2019) report also mentioned that the SIC had likely acted as PF before the fateful flight, further demonstrating a systemic lack of rule adherence or antiauthority attitude. The first officer's lack of airmanship and attitude of resignation likely overwhelmed the PIC, leading to additional distraction. As a result of the PIC's distraction level, the PIC suffered a complete loss of situational awareness (SA) throughout the flight. This event began when the crew failed to perform their preflight duties and chose to depart without the current Teterboro weather and on an unrealistic flight plan, demonstrating one of the operational pitfalls – neglect of flight planning (FAA, 2016, pp. 2-22).

Crew Resource Management Issues

Despite attending the FAA mandated crew resource management (CRM) training for Part 135 operators, the crew exhibited a disregard for proper checklist and briefing criteria required by the company's General Operating Procedures (GOPs) during the flight. This failure led to insufficient understanding of the elements of the circle-to-land procedure, causing a further loss of situational awareness upon entering the terminal environment, which showed a lack of information management. The PIC's inability to ascertain his position throughout the flight, a skill-based error (Reason, 1997), further compounded this loss. Not only was the PIC lost, but he also displayed arrogance, a mixture of machismo and invulnerability, that precluded any urgency in regaining SA. The absence of a strong safety culture, the lack of communication, poor teamwork, and inefficient workload distribution exposed the PIC's weaknesses as a pilot when he reluctantly accepted the flight controls for the flight's final moments.

Training and Airmanship

Company policy prohibited the SIC from performing PF duties due to his low total flight time and difficulties in training (NTSB, 2019). Several factors contributed to the SIC's inability to aviate without the assistance of the PIC. He demonstrated his lack of experience in turbine-powered aircraft through knowledge and skill-based errors. Additionally, among the training difficulties noted by CAE, the simulator flight training company that administered the SIC's initial training, the SIC had performed poorly on circle-to-land maneuvers similar to the Teterboro approach. Investigative interviews also discovered the SIC's "hit or miss" performance as a line pilot, consistent with the company's restriction on his activities (NTSB, 2019, p. 10). Unfortunately, there was no company system in place to address the SIC's qualification weaknesses, further highlighting the need to enhance the pilot qualification training and overall safety culture.

Non-Punitive Reporting System & Lack of FAA Oversight

In either the FAA or ICAO rubric, operators must create a non-punitive reporting system to allow anonymous reports, comments, and safety alerts. Without a non-punitive reporting system or working safety system in place, management had little or no ability to identify underperforming crew members after they left training. While the company intended a non-punitive reporting system, the designation of a safety manager with supervisory authority over the pilots ensured its failure, leaving many hidden or undisclosed problems. The FAA also provided low levels of safety oversight and demonstrated a lack of interest in expanding those levels of support; as the NTSB (2019) investigation noted, the company's FAA Principal Operations Inspector (POI) had never performed an inflight check on a Part 135 carrier. The NTSB final report did show that, aside from the plan to implement a safety management system (which did not occur) and limited third-party safety audits, little else happened before or after the accident.

SMS Implementation for Part 135 Air Taxi Service Providers

The language of the NTSB safety recommendation, A-16-36, only asked that the FAA mandate that Part 135 carriers maintain an SMS. The researchers chose to use 14 CFR Chapter I Subchapter A Part 5 as it demonstrated the FAA's expectations of an SMS, despite its unsuitability to most Part 135 operators. To simulate how Part 5 would challenge Part 135 safety teams, the researchers created Figure 1 to demonstrate a Part 5 compliant SMS' complexity.

They examined Part 5 with the help of the FAA's voluntary SMS guide for non-121 air operators, as well as the ICAO's Annex 19 – Safety Management (2016).

A company could not simply tell its crews not to make the same mistakes and expect that the same circumstances would not recur (Smith, 2006). Without a change in the company's safety culture starting from a hazard reporting system, the company could not expect a significant, lasting change in its safety performance (Leib & Lu, 2013).

Safety vs. Budget Constraint

Given the company's small size and the aircraft's age, a comprehensive flight data monitoring (FDM) program would not be possible. The original cockpit voice recorder (CVR) and flight data recorder models did not yet collect enough discrete data or retain it for a long enough period to allow collection and evaluation, much less an effective Flight Operation Quality Assurance (FOQA) program (FAA, 2004). Our research also noted that the company was not the owner of any aircraft it operated. According to a broker, the company, therefore, could only recommend conversions to an aircraft's owner(s) if it were so inclined. The Part 135 management and charter of these privately owned aircraft would become far less lucrative if the owners faced an FAA mandate to install FDM equipment costing more than one-quarter of the aircraft's value which would not increase the aircraft resale value (R. J. Smith and R. L. Smith, multiple personal communications, April 2021).

However, with the availability of the FAA's Aviation Safety Information Analysis and Sharing (ASIAS) program, the company could both learn from industry-wide safety information and contribute to safety improvement throughout the industry. To present early concerns on known risks, the FAA designed ASIAS to accept all forms of safety data, including an SMS' manual hazard reporting or other methods not reliant on the high-technology methods that would be impractical for companies facing budget constraints. ASIAS' deidentified aggregate safety-related data are available to the airline industry for cross querying and lessons learned purposes (FAA, n.d.). The FAA also indicated that it could not use ASIAS data against operators participating in the program, which would protect the company from enforcement actions based on information submitted directly to the program by the company or its employees.

What mechanisms of Safety Management Systems could FAA FAR Part 135 Air Taxi service providers use to mitigate similar risks?

Commitment

As noted earlier, a successful SMS begins with a commitment from the top management through its safety policy. Given this Part 135 company's history and its relatively small size, the chief executive officer/president (CEO) should sign this policy and announce the beginning of this program to the employees and other stakeholders in the company. Besides showing visible support to the program, the safety policy should also designate a different employee as the safety program manager, thereby eliminating the current conflict of interest posed by having the director of operations serve in that role.

Reporting and Informed Cultures

As a counterintuitive example, an increased number of safety reports indicates positive safety system performance and an improving reporting culture rather than greater risks to the company. The content of those reports may serve as the indicator of an unknown risk (e.g., multiple reports of pilots continuing un-stabilized approaches beyond the limits prescribed within the company SOPs). The safety committee should then track each safety, incident, and accident report, including the actions taken in response to the report and follow-up assessments of the effectiveness of those actions to shape the informed culture.

Just Culture

A non-punitive policy should come with establishing a company safety committee, comprised of a representative from each department of the company and chaired by the safety program manager. Embracing *just* concepts, the safety committee would be responsible for recommending safety policies to company management, reviewing incidents, accidents, or other safety reporting, and conducting safety training within members' respective departments. From the outset, the safety committee members would participate in developing and implementing the SMS.

Learning and Adaptive Culture

The learning culture finds its roots in safety assurance. The company must solicit authored and anonymous safety reporting for continuous safety education and promotion.

Continuous Gap Analysis

Part 5, ICAO Annex 19 (2016), and the various SMS audit standards provide comprehensive lists of those policies and activities that will be mandatory subjects of gap analysis. Still, committee members should strive to add other activities with potential hazards. This gap analysis would initially identify and document the current activities that the department performs to mitigate identified risks, in effect taking credit for work already completed. It would then identify and document those hazards and associated risks that the department has either not identified or identified and not addressed.

Continuous Risk Assessment

After compiling the gap analysis, the committee members should assess the company's existing and anticipated risks regarding both their severity (S) and their probability (P), rating in a Risk Matrix as a low, medium, or high risk, according to a rubric adopted by the committee.

DOI: https://doi.org/10.15394/jaaer.2022.1934

The committee should also determine the actions necessitated by each level of risk and, after applying those actions to mitigate the initial risk, rate the residual risk. This risk assessment system must also include the company's policy on conducting activities based on their residual risk rating (e.g., the company might choose not to conduct any activities with a high residual risk rating, activities with a medium residual risk rating might require CEO or director of operations approval, and no action may be necessary for activities with a low residual risk rating). In each area of the company's activities, committee members should also establish a way to measure leading indicators of potentially increased risk or positive safety system performance.

Safety Promotion and Assurance

The participation of each department's representatives in these processes would then become the first stage of SMS promotion within the company. The company should also develop initial and periodic SMS training for its employees, managers, and safety committee members. Senior management should consider the development of a company safety newsletter or regular email, which should include reporting highlights, information of particular interest from the ASIAS database or NASA Aviation Safety Reporting Program (ASRP), and other relevant safety subjects. Many aviation organizations also develop incentives for employee contributions to the SMS, and the safety committee would recommend the recipients of these incentives to the CEO.

Leadership Visibility and Involvement

Employees and other stakeholders should see the senior managers embrace the SMS at each step, especially the CEO. Without the CEO's overt and active support, the SMS would comprise little more than paperwork and meetings, and this engagement would reform the foundation for the company's safety culture. The combination of senior-level engagement, floor manager support, and SMS training/other forms of SMS promotion will begin to create a shift in employee attitudes. This new architecture will lead them to trust that the system exists for their benefit, rather than serving as a mechanism for employees to report each other or managers to punish employees. While an effective SMS includes sanctions against employees who refuse to comply with company policies, including its SMS policy, employees should see the system's positive outcomes much more frequently to remain engaged.

Conclusion

Though the FAA does not require Part 135 operators to implement SMS, these operators must nevertheless act demonstrably to ensure the safety of their operations. While financial cost can impede air taxi providers in implementing optional programs, implementing an SMS costs far less than restoring the company's good standing. The company's financial survival and reputation with customers, shareholders, insurers, regulators, and, most of all, its employees suffer a great deal after a significant accident.

By virtue of our close analysis of the NTSB accident report using Fishbone Ishikawa Analysis and FTA in conjunction with decades of industry experience in air operation and safety, the benefits of SMS toward the improvement of Part 135 aviation safety culture appeared obvious. We then assembled a plan to invigorate the company's safety program and begin rebuilding its safety culture on the solid foundation of safety policy, risk analysis, safety assurance, and promotion. The plan required that senior managers demonstrate positive support and commitment to lead the safety committees and the employees' involvement in developing the safety program. Such participation at all levels of the organization would create a successful safety program, which cannot exist without an effective non-punitive hazard reporting system.

DOI: https://doi.org/10.15394/jaaer.2022.1934

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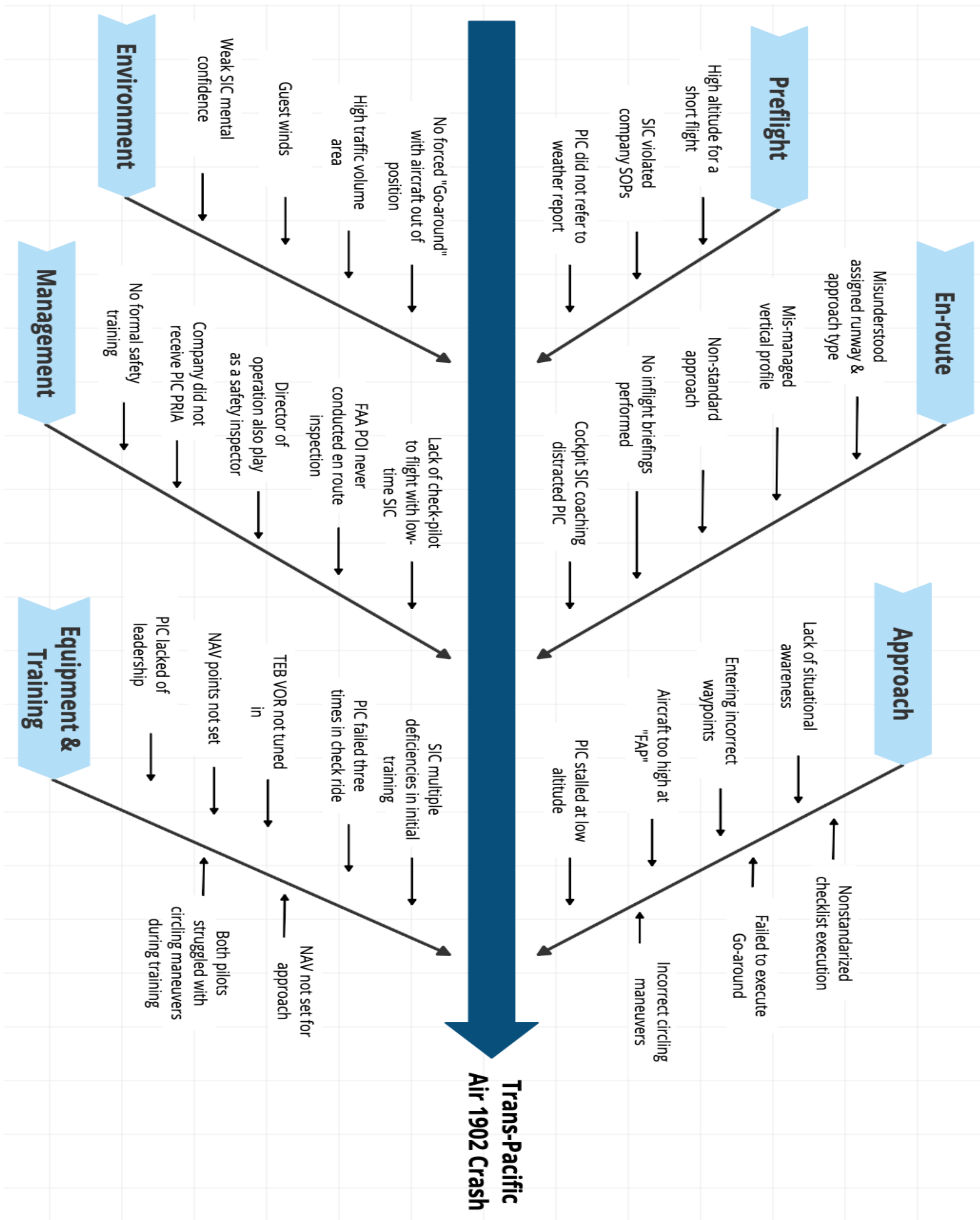
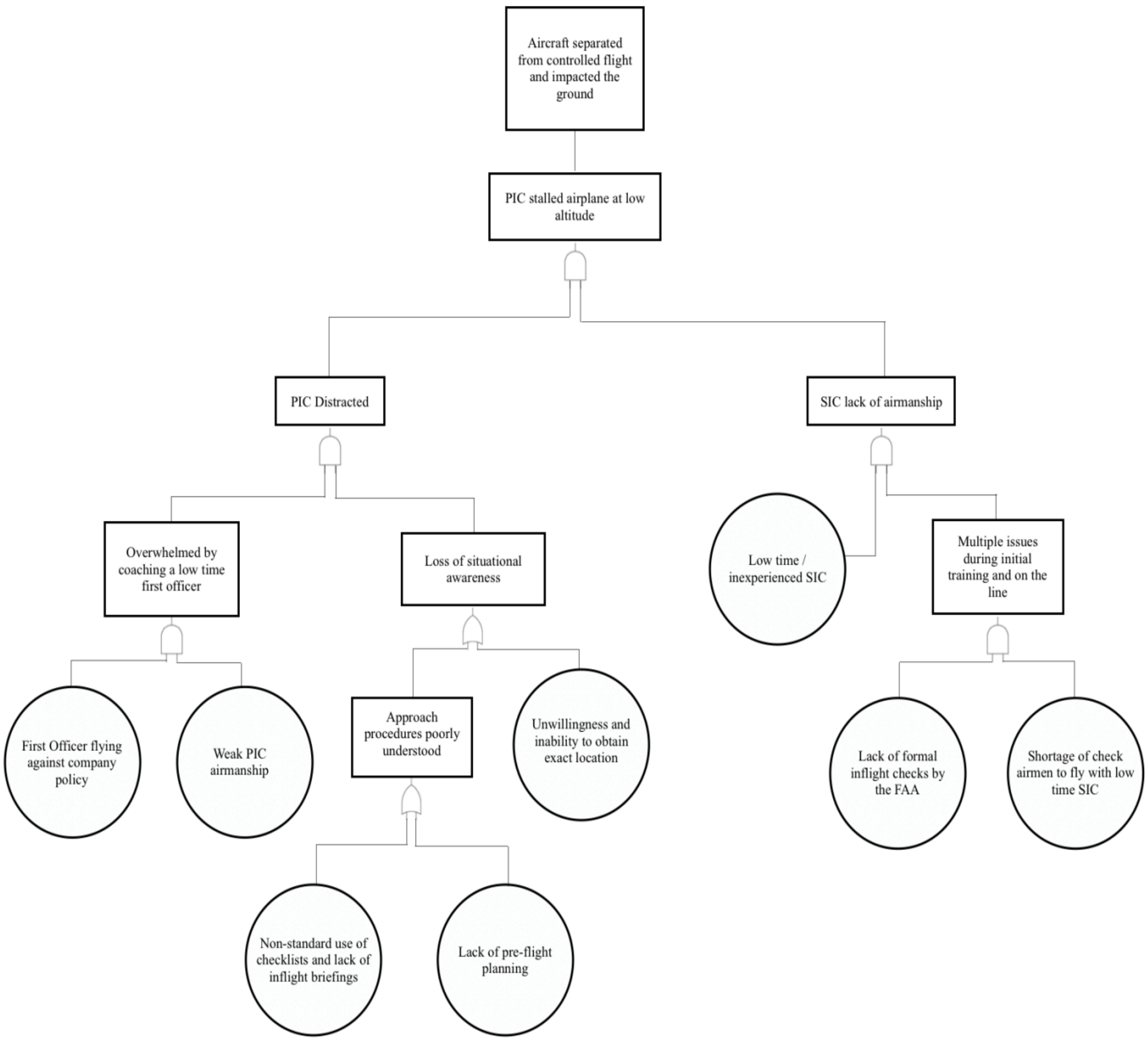
Appendix A

Fishbone Analysis Diagram



Appendix B

Fault Tree Analysis Diagram



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