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Greater Understanding of Human Factors will Lead to Improved Aviation Safety

Alaba Gabriel Idowu
Embry-Riddle Aeronautical University, idowua1@my.erau.edu

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Greater Understanding of Human Factors will Lead to Improved Aviation Safety

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The objective of this research was to reveal the impact of human factors on flight safety and provide corrective recommendations that can mitigate human errors in the aviation industry. The method of investigation included an evaluation of the crash of Avianca Airlines Flight 052, which resulted in findings of probable cause of the accident and evaluated how human factors, including a lack of effective communication, stress, fatigue, complacency, lack of awareness, norms, assumptions, and pressure affected the safety of flight. In addition, an analysis of the data and information synthesis was done to arrive at results, conclusions, and recommendations to improve aviation safety. The corrective recommendations that were considered include: (a) promoting human factors awareness to enhance human performance, increase the awareness of hazards associated with flight operations, improve safety consciousness, introduce newly identified hazards, and improve aviation safety; (b) implementation of aeronautical decision making (ADM) and risk management (RM) cognitive tests in flight training curriculum to mitigate threats and errors, improve aviation safety, and help determine pilots' thinking and reasoning abilities on risk management and decision making; (c) encouragement of a high standard of professionalism in all aviation sectors; and (d) having an excellent reward package for pilots. The conclusion of the study confirmed that a greater understanding of human factors would improve aviation safety due to the enormous impacts human factors have on flight safety and that adequate awareness regarding human limitations will minimize human errors and ensure improved human performance in the aviation industry.

Introduction

Human error is progressively seen as the main factor contributing to aircraft accidents and incidents more than aircraft technical failure (Munene, 2016). Human errors include errors by the flight crew, maintenance personnel, air traffic controllers, and others who directly impact flight safety (National Research Council, 1998). Experts used to believe the causes of aircraft accidents were aircraft technical failures (Gong et al., 2014). After a couple of research studies, "approximately 80 percent of all major accidents and incidents were attributable to human errors" (Munene, 2016).

Aviation accidents are known to be a product of a chain of unsafe acts by the elements that have touched the flight (Kanki et al., 2019). According to the Human Factors Analysis Classification System (HFACS), organizational influence, supervisory factors, preconditions for unsafe acts, and unsafe acts are sources of human errors in the aviation industry (Federal Aviation Administration, 2001). Thus, most of the technical failures experienced in aviation accidents and incidents originated from human errors (Munene, 2016).

In a review of 200 commercial air transport accidents and incidents from 2000 to 2016, Kharoufah, et al., (2018) found situational awareness, non-adherence to standard operating procedures, fatigue, incapacitation, communication, distraction, alcohol, and drug as major human factors leading to aircraft accidents and incidents. Out of these factors, situational awareness was the most significant human factor causation of aircraft accidents and incidents (Kharoufah, et al., 2018). Härtel, et al., (1989) also recorded that a lack of situational awareness was the leading causal factor of accidents and incidents in a review of military aviation mishaps. This necessitates the need for human factors awareness in the aviation industry to improve human performance.

Intent

Humans are prone to errors that can be detrimental to the safety of flight (Faaborg, 2003). This is because errors are consequences of human actions or inactions that reduce safety margins and lead to deviations from operational rules (Wiegmann et al., 2005). Thus, the intent of this paper was to review and evaluate the crash

of Avianca Airlines Flight 052 using the Human Factors Investigation Tool (HFIT) to identify human factors elements that contributed to the probable cause of the accident and their impact on future operations in the aviation industry. In addition, this paper also aimed to provide corrective recommendations that can help in mitigating human errors in the aviation industry.

Research Questions

•What human factors elements contributed to the probable cause of the crash of Avianca Airlines Flight 052?

•How do organizational norms impact flight safety?

•How can human errors be mitigated in flight operations?

Literature Review

The aviation industry is one of the fastest-growing industries and the safest means of transport (Sarkar, 2012). Nevertheless, the aviation industry has recorded many accidents and incidents linked to human errors (Faaborg, 2003). Research showed that the concept of human factors is a significant concern in the aviation industry (Dumitru & Boşcoianu, 2015) and has contributed to many aviation accidents more than other factors (Munene, 2016). Many of these accidents resulted in death and injuries and negatively impacted global aviation (Low & Yang, 2019).

In 1979, the National Aeronautics and Space Administration (NASA) organized a conference targeted at addressing factors leading to aircraft accidents and incidents in commercial aviation and discovered that most of the accidents and incidents were linked to human factors (Helmreich, et al., 1999). In addition, NASA identified the human errors aspect of most air crashes as failures of interpersonal communication, decision-making, and leadership (Helmreich, et al., 1999). The conference's outcome led to the evolution of cockpit resource management that later changed to crew resources management (Lofaro, & Smith, 2012). Cockpit resources management was first initiated by United Airlines in 1981 and focused on correcting deficiencies in individual behavior such as a lack of assertiveness by juniors and authoritarian behavior of captains (Helmreich, et al., 1999).

Understanding human factors involve gathering information about human abilities, limitations, and other characteristics and applying it to tools, machines, systems, tasks, jobs, and environments to produce safe, comfortable, and effective human use (Graeber, n.d.). Human factors can be categorized under four methods or measure headings: flight performance, nonflight performance, physiological, and subjective (Wise et al., 2010). Flight performance of human factors describes how pilots and aircraft are interconnected as a system, and the physiological measures include hypoxia, noise level, fatigue, alcohol, drugs, and workload (Wise et al., 2010). Understanding these measures gives pilots a better understanding of the hazards associated with flight operations (Wise et al., 2010).

The term “human factors” in flight operations is beyond pilot errors (Wiegmann & Shappell, 2001). Organizational influences and supervisory factors are part of human factors elements leading to aircraft incidents and accidents (Wiegmann & Shappell, 2001). According to Dr. Scott Shappell and Dr. Doug Wiegmann (2001), organizational culture, operational process, resource management, inadequate supervision, planned inappropriate operations, failure to correct the known problem, and supervisory violation are part of human factors leading to aircraft accidents and incidents. In an effort to mitigate human factors problems, researchers like Gordon Dupont recognized several factors contributing to human errors (Nzelu et al., 2018). Gordon Dupont identified lack of communication, complacency, lack of knowledge, distraction, lack of teamwork, fatigue, lack of resources, pressure, lack of assertiveness, stress, lack of awareness, and norms

as human factors contributing to human errors (Nzelu et al., 2018).

Stress and fatigue are notable human factors capable of downgrading human performance (Guastello, 2014). Their negative impacts on mood, memory, concentration, decision-making, emotional state, and information processing are apparent in many aviation accidents (Kanki et al., 2019). Stress can be classified as psychological and physiological (Guastello, 2014). Psychological stress contributes to various mental and physical conditions, while physiological stress is indicated by an unpleasant sensory, emotional, and subjective experience associated with potential damage of body tissue and bodily threat (Kogler et al., 2015). Stress and fatigue make pilots susceptible to errors of commission and errors of omission (Guastello, 2014). Errors of commission occur when the operator intends to take an action that needs to be taken but selects the wrong action or pushes the wrong button, and errors of omission occur when the operator fails to take needed action (Guastello, 2014).

A lack of effective communication has become one of the prominent human factors problems contributing to aviation incidents and accidents (Kanki et al., 2019). Communication is an essential component of risk management in flight operations, and it exists between pilot and dispatch, pilot and air traffic control (ATC), and among flight crews (Kanki et al., 2019). Communication modes in flight operations include verbal, hand gestures (body language), written, and data links (Kanki et al., 2019). Krivonos (2007) stated that “communication-related issues comprised a sizeable portion of National Aeronautics and Space Administration (NASA)’s Aviation Safety Reporting System (ASRS) database since its inception and over 70 percent of the reports within the first five years were either directly or indirectly related to communication issues and problems” (p. 3). Communication plays a significant role in maintaining situational awareness, and it enhances crew coordination and attention to manage all required activities in the flight deck (Kanki et al., 2019).

Complacency is a feeling of self-satisfaction followed by a lack of awareness of potential danger (Kanki et al., 2019). It’s often seen as overconfidence from repeated experience on a specific activity, and it presents obstacles to maintaining situational awareness and reduces the pilot’s effectiveness in the flight deck (Kanki et al., 2019). Parasuraman and Manzey (2010) stated that “automation complacency occurs under conditions of multiple-task load when manual tasks compete with the automated task for the operator’s attention" (p.1).

Data Collection and Analysis Plan

Post-accident and incident data analyses are useful information for the aviation industry to ensure improved flight safety from the lessons learned the hard way (Kharoufah et al., 2018). Therefore, to address the problem stated, the crash of Avianca Airlines Flight 052 was analyzed using Human Factors Investigation Tools (HFIT) to identify human factors elements that contributed to the probable cause of the accident and their impact on future operations in the aviation industry. The data was collected through the report generated by the National Transportation Safety Board (NTSB, 1991).

The History of Flight

Avianca Flight 052 departed Bogota, Columbus, intending to land at New York International Airport on July 19, 1989 (NTSB, 1991). However, the flight crashed in a wooded residential area in Cove Neck, Long-Island, New York, due to poor weather conditions in the northeastern part of the United States (NTSB, 1991).

The flight was placed in holding patterns three times, which led to exhausting almost all the aircraft's fuel (NTSB, 1991). After a while, the crew received clearance to land but could not make it on the first landing attempt due to inclement

weather. As a result, the crew executed a missed approach and reattempted the approach (NTSB, 1991). However, the flight could not make it back to the airport because of the fuel condition and crashed in a wooded residential area in Cove Neck, Long Island, New York (NTSB, 1991).

Analysis

HFIT is a model that uses four steps to analyze and evaluate incidents and accidents. The steps involved are "(a) the action errors occurring immediately prior to the incident, (b) error recovery mechanisms, in the case of near misses, (c) the thought processes which lead to the action error and (d) the underlying causes" (Gordon, Flin, & Mearns, 2005).

Step 1: Action Errors Occurring Prior to the Accident:

Several errors contributed to the crash of Avianca Flight 052. One of the human factors elements that set the stage for the accident was the pressure from the management in Washington DC (Air Crash Investigation, 2015). The traffic control management in DC pressured New York tower to take more flights than they felt safe despite the deteriorating weather at the airport (Air Crash Investigation, 2015). The control tower personnel at New York Airport believed landing 33 aircraft per hour would be unsafe and advised to divert traffic to other airports. However, the management in Washington in DC pressured them to land 33 aircraft per hour. This was the reason for continuous holding instructions given to Avianca Flight 052 (Air Crash Investigation, 2015).

A lack of effective communication played a significant role in the crash of Avianca Flight 052 (NTSB, 1991). The crews failed to declare an emergency when it was apparent that the flight needed to be prioritized over other aircraft due to its fuel state (NTSB, 1991). The regulation says, "an aircraft is in at least an urgency condition the moment the pilot becomes doubtful about the position, fuel endurance, weather, or any other condition that could adversely affect flight safety" (FAA, 2020, p. 6-1-2). The word "emergency" was never mentioned to the ATC, even though the captain instructed the first officer to declare an emergency when it was apparent that the flight was running out of fuel (NTSB, 1991).

A lack of situational awareness regarding the fuel state was one of the errors that occurred before the accident (NTSB, 1991). The crews apparently paid no attention to the fuel state until they burnt off alternate and reserve fuel while holding (NTSB, 1991). As a result, the flight crashed due to fuel starvation 47 minutes after the flight engineer stated the fuel would be insufficient to make it to the alternate (Air Crash Investigation, 2015).

Complacency was another human error that played an active role in this accident (NTSB, 1991). Complacency is often seen as overconfidence from repeated experience on a specific activity, and it presents obstacles to maintaining situational awareness and reduces pilot's effectiveness in the flight deck (Kanki et al., 2019). The flight crewmembers had been to JFK several times and were comfortable to embark on that flight without reviewing the weather information (Air Crash Investigation, 2015). Unfortunately, the weather information provided by dispatch was not the latest by the time the flight departed, and the crews failed to obtain updated weather and traffic information during the en-route phase of the flight to inform them of the deteriorating weather at JFK and plan for a suitable alternate airport (Air Crash Investigation, 2015).

Step 2: Error Recovery Mechanisms, in the Case of Near Misses:

No error recovery mechanism.

Step 3: The Thought Processes Which Lead to the Action Errors:

Assumptions were seen as part of the thought processes that led to the action errors. For example,

the crews thought of diverting to another airport after a couple of holding patterns but ignored the decision based on the assumption that they were given priority when they were being vectored and given a lower altitude (NTSB, 1991). Trusting the ATC more than the situation at hand was another thought process that led to the action errors (Air Crash Investigation, 2015). During the first series of holding patterns, the crews trusted the judgment of the ATC and failed to take necessary actions by diverting to the alternate airport (Air Crash Investigation, 2015).

Step 4: The Underlying Causes or Threats That Contributed to the Accident:

The accident's underlying probable cause was the failure of the flight crew to adequately manage the airplane's fuel load and their failure to communicate an emergency fuel situation to air traffic control before fuel exhaustion occurred (NTSB, 1991). The inability of the flight crewmembers to use an airline operational control dispatch system to assist them during the international flight into a high-density airport in poor weather also contributed to the underlying cause of the crash (NTSB, 1991). In addition, "the inadequate traffic flow management by the Federal Aviation Administration and the lack of standardized understandable terminology for pilots and controllers for minimum and emergency fuel states are contributing factors to this accident" (NTSB, 1991).

In-flight stress and fatigue were developed through a series of unplanned events and contributed to the crews' poor aeronautical decision-making (Air Crash Investigation, 2015). In addition to a series of unplanned events that developed, reports showed that autopilot was inoperative (Air Crash Investigation, 2015). This made the captain hand-flew the aircraft throughout the flight, and as a result, he became exhausted prior to the first landing clearance (Air Crash Investigation, 2015).

Organizational norm was likewise identified as part of the underlying causes of this accident (Air Crash Investigation, 2015). According to the report, the weather forecast showed JFK would have restricted visibility near or below the authorized minimum to execute an approach (Air Crash Investigation, 2015). When the flight departed, the current weather data showed all planned alternates, including Boston International Airport, were forecast to be below the authorized minimum for alternate airports (Air Crash Investigation, 2015). However, due to Avianca's dispatch culture, Boston International Airport was listed as an alternate airport on the computer-generated flight plan as it had always been for all flights to JFK (Air Crash Investigation, 2015). This organizational norm showed that the management of Avianca Airlines lacked adequate dispatching services for Avianca Flight 052 (Air Crash Investigation, 2015).

Results

In the analysis of this accident, eight human factors problems were traceable to the Flight Crew, Airline Management, and Air Traffic Controllers (ATC). A summary of these classifications can be found in Table 1 below.

Table 1: Classification of human factors problems indetified in Avianca Flight 52.

Flight Crew and Organization Human Factors Problems	
• Lack of Communication	• Fatigue
• Stress	• Lack of Situational Awarenes
• Complacency	• Organizational Norms
Assumptions	
Air Traffic Control Human Factors Problems	
• Pressure	

The analysis of the crash also revealed the following (1) a lack of effective communication among flight crew members could result in assumptions and eventually lead to loss of situational awareness, (2) Effective communication enables flight crew members to manage all available resources to ensure flight safety, (3) Complacency makes flight crew become lackadaisical and delay or ignore essential duties that can ensure flight safety, (4) organizational norm is a habit that needs to be broken to improve aviation safety because it can set the stage for accidents, especially in situations where special consideration are needed (5) pressure inhibits sound aeronautical decision-making and can lead to accepting unnecessary risks (6) stress and fatigue affect flight performance and make flight crew susceptible to errors.

Conclusion

The analysis of the crash of Avianca Airlines Flight 052 revealed that a greater understanding of human factors would improve aviation safety due to the enormous impacts human factors have on flight safety. Adequate awareness regarding human limitations will minimize human errors and ensure improved human performance in the aviation industry. Human factors elements such as complacency, lack of effective communication, lack of situational awareness, pressure, assumptions, organizational norms, stress, and fatigue played significant roles in the crash of Avianca Airlines Flight 052. Situational awareness is critical to flight safety as a loss of it can trigger other human errors. Loss of situational awareness regarding fuel state was the main factor that led to the crash, and a lack of effective communication prevented air traffic controllers from giving the flight adequate assistance.

Aviation accidents are products of a chain of unsafe acts by the elements that have touched the flight (Kanki et al., 2019). Breaking the chain at the managerial level can minimize flight crew errors and ensure safety. The analysis revealed organizational norms have a huge impact on flight safety as lapses in organizational safety policies can induce pilot errors and set the stage for incidents and accidents. This revealed that addressing human factors issues at the managerial level would positively impact flight safety.

Recommendations

Human factors awareness is essen tial to improve human performance and create an environment that ensures safety in the aviation industry. Human factors awareness training will enhance human performance, increase the awareness of hazards associated with flight operations, improve safety consciousness, introduce newly identified hazards, and improve aviation safety. Human factors awareness is not a new concept in the aviation industry; most companies include it in their training program (Kanki et al., 2019). However, for effectiveness, it should be integrated into the training curriculum for both parts 61 and 141 training programs so that student pilots and flight instructors can get acquainted with factors affecting human performance and recognize hazards associated with flight operations in the early days of their career. Getting acquainted with factors affecting human performance in the early days of their career will make them develop a safety-conscious attitude and nurture it as they progress. Introducing human factor awareness training in flight schools will also create an unshakeable impression about the importance of human factors in aviation.

Human factors awareness training should be conducted by an aviation human factors specialist who will thoroughly cover aviation-related topics. The training should be a visual presentation to have a lasting effect on the learners. Studies have shown that visual stimuli can stick in the long-term memory faster than any other form of stimuli, and it improves comprehension, activates emotions, speeds up motivation, and strengthens learning and retention in humans (Goldstein, 2014). This form of training should be conducted annually to refresh memory and ensure pilots are not losing important safety-related knowledge. Research revealed that learners rapidly

lost the memory of learned knowledge in a matter of days or weeks unless the information is consciously reviewed (Goldstein, 2014). Therefore, to help pilots avoid losing critical safety knowledge, annual human factors awareness training should be incorporated into flight schools' curriculum.

In line with human factors awareness training, the concept of aeronautical decision making (ADM), and risk management (RM) should strongly be emphasized. Even though ADM and RM have long been introduced in the aviation industry and have helped pilots develop vital skills to stay safe in all flying activities. However, research showed that most aviation accidents, especially weather-related accidents, are linked to pilots accepting unnecessary risk and not actively integrating risk management into flight planning (Kanki et al., 2019). Combating this problem requires periodic assessment of ADM and RM skills in the form of a cognitive test to ensure pilots have the skills to identify hazards, analyze risk control measures, make control decisions, and implement risk controls. Implementation of ADM and RM cognitive tests will mitigate threats and errors in flight operations, improve aviation safety and enhance pilots' risk management and decision-making skills. Any pilot who scores below 80 percent in ADM and RM cognitive test should be required to retake the test and score a minimum of 80 percent before being allowed to act as pilot in command but could act as second-in-command in a multicrew operation.

Encouragement of a high standard of professionalism in all aviation sectors will positively impact flight safety. Professionalism is seen as a pursuit of excellence through discipline, display of competence, setting high personal standards, ethical behavior, and continuous improvement, which have instantaneous and positive impacts on aviation safety. Pilots who value a high standard of professionalism build a library of current procedures and publications resources and participate in educational opportunities in the industry (Turgut, 2019). Encouragement of professionalism can be done through a rating system that will continuously evaluate aviation professionals on all aspects of professionalism. The rating should be done monthly, so that pilots can know how well they are rated on the professionalism scale and improve in areas they are falling behind. To ensure this is taken seriously, pilots should be made aware that monthly professionalism ratings will be kept on file and can be made available if a new employer requests them.

Having an excellent reward will have a positive impact on aviation safety. Research showed that the pilot salary for airlines without a crash is significantly higher than that of airlines with crashes (Low & Yang, 2019). This shows that reward packages have a direct impact on safety. An excellent reward system is a form of motivation that will encourage pilots to perform their jobs optimally, pay attention to safety procedures, and avoid distractions that can affect performance. Research revealed that motivation significantly improves employees' performance (Ghaffari et al., 2017). Unfortunately, the current reward system of most pilots is not encouraging and therefore forces them to pick up other jobs that end up affecting performance in flight (Ghaffari et al., 2017). A pilot's job is risky, yet the salary of some non-flying staff in most organizations is greater than most pilot salaries (Ghaffari et al., 2017). This unfair situation can make pilots feel discouraged and unsatisfied with the job. Research revealed that high job satisfaction significantly affects job performance and leads to high productivity (Bako, 2012). For pilots and aircraft mechanics to derive motivation that will enable them to perform their job optimally, they need to be well paid.

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