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A review of human factors causations in commercial air transport accidents and incidents: From to 2000–2016

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ABSTRACT

Human factors have been defined by the International Civil Aviation Organization (ICAO) as "about people in their living and working situations; about their relationship with machines, with procedures and with the environment about them; and about their relationships with other people (at work)". Human factors contribute to approximately 75% of aircraft accidents and incidents. As such, understanding their influence is essential to improve safety in the aviation industry. This study examined the different human factors causations in a random sample of over 200 commercial air transport accidents and incidents from 2000 to 2016. The main objective of this study was to identify the principal human factor contributions to aviation accidents and incidents. An exploratory research design was utilised. The qualitative data were recorded in a database, and were coded into categories about the flights (including date, manufacturer, carrier, state of occurrence, etc). These categories were then analysed using Chi-Squared tests to determine which were statistically significant in terms of having an influence on the accidents/incidents. The most significant human factor was found to be situational awareness followed by non-adherence to procedures. In addition, charter operations proved to have a significantly higher rate of human factor related occurrence as compared to other type of operations. A significant finding was that Africa has a high rate of accidents/incidents relative to the amount of traffic and aircraft movements. These findings reflect some of the more noteworthy incidents that have received significant media attention, including Air Asia 8501 on the 28th of December 2014, TransAsia Airways 235 on the 4th of February 2015, and Air France 447 on the 1st of June 2009; these accidents resulted in a significant loss of lives where situational awareness and non-adherence to procedures were significant contributing factors.

1. Introduction

1.1. Aim

The purpose of this study is to assess the role of human factors (HFs) in commercial air transport accidents and incidents from 2000 to 2016. The aim of this assessment is to provide the aviation industry with analytical insights to positively impact aviation safety. To provide better granularity, differences were assessed across 1) world regions, 2) types of commercial air operation, 3) phases of flight, and 4) type of human error. To facilitate this assessment three research questions were identified.

1. What are the most common HFs causes in commercial air transport accidents and incidents over the period from 2000 to 2016?
2. How are HFs causes distributed by type of operation in commercial air transport accidents and incidents attributed to HFs causation over the period 2000 to 2016?
3. How are HFs causes distributed by world region (both state of operator and state of occurrence) in commercial air transport accidents and incidents attributed to HFs causation over the period 2000 to 2016?

1.2. Background

"Human Factors" as an idea is a relatively new subject. The concept arose in aviation from work by the UK and North America around the ending of the Second World War [53]. The usage of the term HFs began informally in literature in British Air Force accident investigation reports

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in the 1940s; however, it was first officially used in 1957. The term was used to represent the application of scientific knowledge, facts, models, and theories derived mostly from various areas of human science such as sociology, psychology, physiology/medicine, engineering, management science, and anthropometrics [38].

Human error is by no means unique to aviation; it plays a central role in accidents and financial losses [93]. has defined human error as "any member of a set of human actions that exceeds some limits of acceptability - it is an out of tolerance action, where the limits of acceptable performance are defined by the system." Nowadays, the contribution of human error in aviation accidents has been a major factor as 66% of hull-loss accidents were associated with flight crew in the period between 1992 and 2001 [22]. The impact of human error in general aviation is even more significant. For example, 79% of the fatal accidents that occurred in the United States in 2006 were attributed to pilot error [77].

In addition to safety issues, human error can cause huge financial losses for the airline industry in the form of tools destroyed, modifications of flight schedules such as flight delays, and fuel costs. For instance, 92% of the collisions between aircraft and ground vehicles or structures at airports that were contributed to human error, not including taxiway operations, costs the airline industry globally about 10 billion US dollars annually [79]. As such, it is essential to understand the role of human errors in aircraft accidents and incidents.

2. Literature review

2.1. Flight crew selection

According to [56] for many years, the primary focus of flight crew selection was on the identification of individuals with superior flying skills and abilities. However [56], explains that, in recent years the aviation community has become increasingly aware that for a flight crew to complete their flight or mission, the flying skills and the ability to work well in a crew situation during the different phases of the flight are necessary. Crew resource management (CRM's) skill tests have been designed to measure problem solving, decision making, and knowledge of how individuals perform under pressure with crew members in the cabin. The authors' findings illustrated that CRM has proved to be more effective than traditional methods based on research from scientists which stated that most aviation accidents are due to miscommunication between crew members in the cockpit.

Another study about flight crew selection presented by Ref. [111]; focused on testing the individual skills of flight crew in addition to conducting structured interviews to enable human resources to select the best flight crew to fly their aircrafts [111]. conclusions were based on substantial research that was completed to find the best method to select pilots. The results illustrated that individuals' tests and structured interviews is the best method, with the authors discovering a positive relationship between good interview scores and continued employment in addition to, a relationship between poor interview scores and flight crew being terminated by the company [111].

Advancement in the aviation sector has led to the discovery of innovative methods, such as profiling [74]. discusses profiling of flight crew based on their personalities and mental health. The profiling process consists of two methods; select-in and select-out. The select-in method helps in estimating the level of knowledge, skills, and other capabilities the candidate has for a given job and consists of psychological testing and measuring the personal traits executed from the analysis of the job task. While the select-out method, includes medical techniques and an assessment of psychopathology to observe psychiatric fitness [74].

Another study about pilot selection authored by Ref. [41] focused on the importance of situational awareness of flight crew in the process of flight crew selection. The authors demonstrated the significance of situational awareness for flight crew to execute the correct action in a short period that can be less than a millisecond which can be very decisive for the safety of the aircraft and passengers. The authors state that the process of selecting flight crew and grouping them as per their level of situational awareness consists of 5 vital individual skills which are: Spatial, attention, memory, perception, and cognitive functions. The 5 skills were defined as:

- *Spatial*: the capability of an individual to interact with the aircraft systems through mental visualization and manipulating objects spatially which are significant for navigational purposes.
- *Attention*: is the focus on significant details in a demanding environment. The distribution of attention across several, competing sources of information and tasks can be a vital challenge for flight crew during the different flight phases.
- *Memory*: Memory consists of working memory and long-term memory stores. Comprehension and projection of future events that need high levels of situational awareness must occur in working memory as people try to integrate information from several sources, compare the information obtained to the goals and objectives forecasted, and then project future scenarios from known dynamics. While long-term memory stores, can reduce the load on working memory. According to the authors, a deft pilot is differentiated by his ability to know the significance of the details during the flight to know whether the information should be stored in the long-term memory or not.
- *Perception*: is the ability of an individual to perceive information in a short period and to stay aware of infrequent signals to take decisive actions.
- *Cognitive functions*: is the capability of an individual to deal with workload and circumvent issues under pressure and extreme environment during the flight.

These five individual skills should be examined separately in the process of flight crew selection to ensure pilots can withstand the demanding and extreme environment during the flight. Therefore, flight crew should be consistently monitored, trained, and developed to ensure their readiness to face all sort of challenges to diminish aircraft accidents in the aviation industry [41].

2.2. Trends in aviation human factors research

The term "human factors" has become increasingly popular in the commercial aviation industry as human error has been recognized rather than technical failure to underlie most aviation accidents and incidents. HFs is a very extensive topic in both its knowledge base and scope. HFs involve the collection of information about human abilities, limitations, and other characteristics and implementing it to equipment, machine, jobs, tasks, systems, and environments to generate a safe, comfortable, and effective usage by a human. In aviation, the knowledge of how a human and technology interact in a safe and effective is part of HFs. This knowledge can then be implemented into various areas such as design, training, policies, or procedures to enhance human performance [20]. Much research has been undertaken on the different HFs causes in aviation accidents and incidents such as fatigue, situation awareness, distraction in cockpit, and many other causes. The following sections discussed the most significant HFs in aviation accidents and incidents such as fatigue, situational awareness, and communication.

2.2.1. Fatigue

Fatigue is considered one of the most critical factors that has an impact on the decision making of flight crew members. For instance [25], presented a study of major accidents in domestic air carriers from 1978 to 1990 produced by the National Transportation Safety Board (NTSB), the study estimated that fatigue contributed to between 4 and 7% of civil aviation mishaps, and data from the US Army Safety Centre suggests fatigue is involved in 4% of Army accidents. In addition, statistics from the Air Safety Centre blame fatigue for 7.8% of Air Force Class-A mishaps. The most significant issue that can be obtained from these data is the