Statistical analysis of aviation incidents caused by crew communication problems

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The purpose of this article is to present a statistical analysis of aviation incidents caused by crew communication problems. The focus was to give an idea of the role that communication plays in aviation and its impact on safety. A database of forty-five aviation incidents was created and reports were analyzed. As a result, it was possible to isolate the factors that contributed to aviation disasters and classify them according to their percentage contribution. The results of the study made it possible to isolate each type of communication that is realistically a problem in aviation. Interaction in pilot-crew and pilot-controller contact was taken into account. The paper contains a number of conclusions regarding the extracted variables and factors that affected the aviation accidents studied.

Keywords: Communication, human communication errors, aviation accidents, statistical analysis, causes of aviation accidents, human factor.

1. Introduction

The continuous development of aviation and the increasing number of flights around the world are creating further challenges for the aviation industry. In this case, flight safety is an extremely important issue that should be constantly worked on to ensure the highest safety standards, thereby eliminating the likelihood of aviation accidents and incidents to a minimum.

The purpose of this article was to conduct a statistical analysis of aviation incidents. Classified important factors that directly contribute to the occurrence of an aviation accident involving errors in communication of those responsible for the safety of flight operations performed.

One of the most important factors affecting flight safety is the correctness and effectiveness of communication between pilots, air traffic controllers and other ground personnel. Aviation accidents caused by communication problems are therefore one of the most serious threats to flight safety. Analysis of aviation accidents is key to improving aviation safety and can help minimize the number of accidents in the future.

2. Communication in aviation

Communication is a process involving at least two people: the sender and the receiver and its

course is often dynamic and requires skillful transmission and processing of information Goździcki (2017). Unfortunately, interpersonal communication is limited by the speed at which information is absorbed and processed.

Communication in aviation is a very important element that determines the safety of flight operations. Depending on the effectiveness and quality of communication between pilots, air traffic controllers, as well as ground personnel, depend on many important decisions and actions taken during flight Ziółkowski et al. (2020). Therefore, errors in communication, misunderstandings, or lack of precise instructions can lead to serious aviation accidents Dvulit et al. (2021), Kaczorek and Jacyna (2022).

2.1. *Types of communication errors*

Communication in a flight crew is one of the most important factors affecting flight safety. However, as numerous reports and studies have shown, errors and misunderstandings often occur, which can increase the risk of aviation incidents and accidents. Communication problems are caused by a number of different factors including complex human characteristics. Among the most important of these are Molesworth and Estival (2015).

- linguistic errors and misunderstandings of the meaning of words,
- ambiguity of the message,
- distortions in communication,
- errors in interpreting information,
- mispronunciation,
- frequency of instructions given,
- stress and fatigue.

These errors can range from minor misunderstandings and flight disruptions to serious aviation accideants. Identifying and understanding the causes of these errors is key to improving flight safety.

2.2. *Crew communication problems*

Effective communication should reign supreme on board the aircraft. According to CRM (Crew Resource Management) requirements, pilots and cabin crew should communicate effectively with

each other, pass on any information to each other, while any situation that may adversely affect flight safety must be reported to the head of cabin crew.
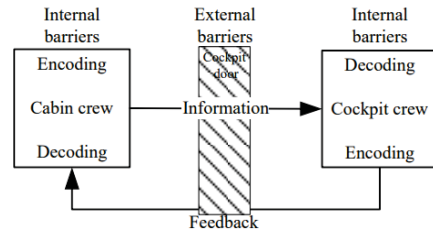

Fig. 1.   Cockpit and cabin crew communication problems

Source: Zhu and Ma (Zhu and Ma)

2.3. *Forecast*

The Figure 1 shows the existing barriers to communication between cockpit personnel and cabin crew. The external barrier is formed by such factors as: noise, confusion, light, but also workload. Internal barriers mainly include: personality, different views or cultural differences. In addition to the above-mentioned factors creating communication barriers, additional issues related to socio-psychological difference, gender difference and trust also play an important role.

2.4. *Communication problems in the crew-controller relationship*

The work of an air traffic controller is extremely demanding and plays a major role for air traffic safety Zieja et al. (2015). Their duties include numerous coordination activities, including the separation of aircraft and the smooth flow of traffic in the air and on the ground. This is why communication between controllers and pilots should be carried out without any errors and their relationship, although it exists only at a distance, should be based on trust. The entire system will work smoothly and efficiently only if the exchanges are carried out with due professionalism.

A common communication problem in the pilot-controller relationship is language barriers. Differing backgrounds and cultures, as well as a

lack of fluency in English, can lead to numerous misunderstandings Mircea cel Batran" Naval Academy and Astratinei (2016). It also happens that controllers use non-standard phraseology or local accents that can be difficult for pilots to understand, leading to miscommunication. Lack of clarity in radio transmissions also happens to be a key problem.

The work of an air traffic controller is extremely demanding and plays a major role for air traffic safety. Their duties include numerous coordination activities, including the separation of aircraft and the smooth flow of traffic in the air and on the tarmac. This is why communication between controllers and pilots should be carried out without any errors and their relationship, although it exists only at a distance, should be based on trust. The entire system will work smoothly and efficiently only if the exchanges are carried out with due professionalism.

2.5. *Human factor in aviation accidents*

The human factor is one of the most common causes of aviation accidents. It is a key element affecting the quality of communication in the crew and between the crew and air traffic controllers Ruishan et al. (2007). The main factors that can cause communication problems in the crew include: stress, fatigue, emotional tension, errors in interpreting information received, insufficient training, or inexperience with communication procedures ICAO (2003). In order to minimize the risks associated with miscommunication of those responsible for the safety of flight operations, these people should be trained in effective communication and in handling stressful situations Wiener (1988) Gosbee (1989).

According to data collected by the International Civil Aviation Organization (ICAO) between 2011 and 2020, the human factor was the cause or co-factor in about 87% of all aviation accidents. The cited data shows that human factor issues are one of the main challenges that the aviation industry has to face in order to improve flight safety Żak et al. (2021).

In aviation, awareness of the importance of human factors in every aspect of aviation work

has been increasing over time. For this reason, various types of systems and models have begun to be implemented that are able to reduce, or predict, the risks associated with human errors Nowakowski, Zieja, Ewertowski, and Żyluk (Nowakowski et al.). A model has been created, the so-called: "Dupont's Dirty Dozen", which determines the factors underlying human errors Osman et al. (2020). This model is used worldwide, among other things: for the analysis of aircraft accidents, but is also used in determining errors made by maintenance workers Jacyna-Gołda (2014).

Fig. 2. Dupont's Dirty Dozen model.

Source: Chatzi et al. (2019)

According to the developed "Dupont's Dirty Dozen" model, one of the factors that can contribute to an aviation accident is communication. According to the Dirty Dozen theory, errors in communication can lead to misunderstandings and inaccuracies in communication, which increases the risk of an accident, or aviation incident Mellema (2018). The model also realizes that communication is a two-way process and each party should fully understand the other Mellema (2018). In view of this, it is important to communicate effectively with those involved in the flight process, such as crew members and air traffic controllers, among others.

3. Statistical analysis

Aviation Safety Network (ASN) is a non-governmental organization that collects and analyzes aviation safety data from around the world. The data provided by ASN includes information on crew, passengers, fatalities, aircraft type, phase

of flight and much more Network (Network). Based on ASN's data, an analysis of flight phases, fatalities, aircraft types and the definition of potential categories of crew communication problems that contributed to an aviation incident was performed.

3.1. *Flight type*

The data shows that commercial flights are most prone to incidents caused by crew communication problems, accounting for 80% of incidents. Cargo flights accounted for 13% of incidents, while military flights accounted for 7%.
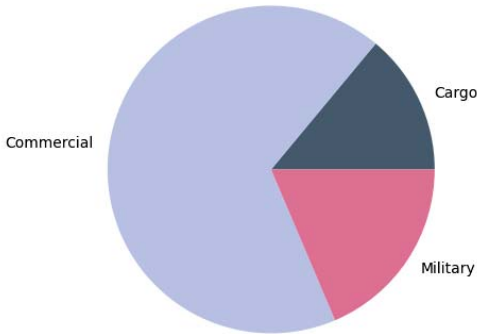

Fig. 3.   Types of flights.

Source: Chatzi et al. (2019)

3.2. *Number of occurrences due to crew communication due to phases of flight*

The highest number of occurrences related to crew communication occurred during the cruise phase with 24 reported incidents, followed by landing approach phase with 17 reported incidents, and take-off phase with 2 reported incidents. Surprisingly, only 2 incidents were reported during the landing phase, which is often considered to be the most challenging phase of a flight. Effective communication is crucial during all phases of flight, but the cruise phase can be particularly susceptible to communication breakdowns due to

the extended duration of this phase and the relative lack of critical tasks to be performed. The landing approach phase, on the other hand, involves a high workload for the crew as they manage the aircraft's speed, altitude, and direction to safely approach the runway.

The low number of reported incidents during the take-off and landing phase is noteworthy and may be attributed to the crew's heightened focus and concentration during these critical phases of the flight Woch et al. (2019). However, it is important to note that any communication breakdown during take-off and landing phase can have catastrophic consequences, emphasizing the importance of effective communication.
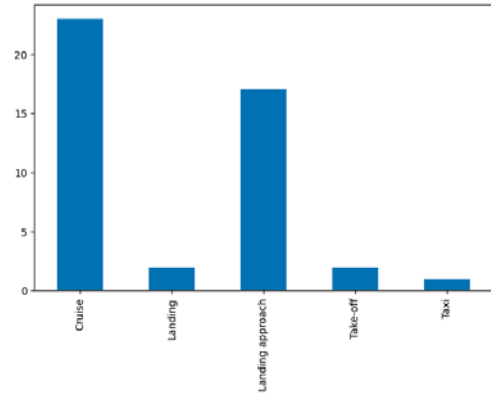

Fig. 4.   Number of air events by flight phase caused by crew communication problems.

Source: Own elaboration based on Network (Network)

3.3. *Causes of crew communication problems*

The classification of causes of aviation accidents was determined at the stage of data collection for statistical analysis. Each case analyzed was considered in terms of the causes of the occurrence of an aviation accident. There were situations in which the accident was influenced by more than one type of traffic problem.

Based on the data provided, the flights can be categorized into several types based on the factors that contributed to the accidents. These factors

include misunderstandings, miscommunications, SOP, language barriers, non-standard phraseology, failure to follow ATC instructions, and ATC misinformation.

The most common factors in all types of flights that contributed most to accidents were misunderstandings and ATC miscommunication, accounting for 51% of all cases studied. Misunderstandings and ATC miscommunication can occur at any phase of a flight, from taxi to landing. They can involve pilots, air traffic controllers, ground personnel, and other stakeholders involved in the operation of an aircraft. In the context of aviation, it can lead to errors in judgment, incorrect actions, and delayed or inappropriate responses. They can also create confusion and uncertainty, which can further exacerbate the situation.

Additionally, statistical analysis revealed that SOP violations contributed to 18% of accidents studied, while language barriers accounted for 13%. These factors emphasize the importance of clear communication and adherence to established procedures in ensuring safe aviation operations. Proper training, language proficiency assessments, and the use of standardized phraseology can help mitigate the impact of language barriers and language barriers in aviation. Implementation and enforcement of effective SOPs can also reduce the likelihood of accidents caused by deviations from established procedures.

Other reasons, such as non-standard phraseology 7%, failure to follow ATC instructions 7% and miscommunication 7% contribute less to communication problems. Non-standard phraseology can lead to confusion and misunderstanding. Using language that is not part of standard aviation phraseology can be particularly problematic if the parties involved are not familiar with the language being used.

3.4. *Fatalities*

The data analyzed in this study include the number of people on board and the number of fatalities. The correlation coefficient between the number of people on board and the number of fatalities is 0.905, indicating a strong linear relationship between the two variables. The data shows that of
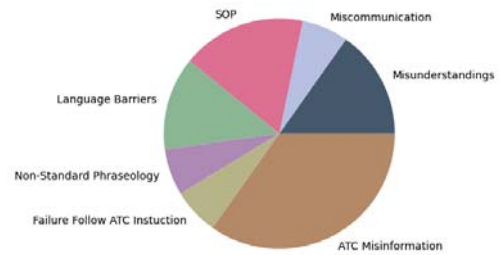

Fig. 5. Types of communication proportion in crew communication problems.

the 45 incidents analyzed, 42 resulted in fatalities, while 3 did not. The total number of fatalities in these incidents was 2,233.

Of particular note are 2 cases with no fatalities, an incident resulting from a communication error between the pilot and ATC occurred on July 19, 1970 in Spain Osman et al. (2020) and on February 17, 1981 in the US Chatzi et al. (2019) due to the omission of information from ATC. Both cases are characterized by the phase of the flight in which the accident occurred is successively take-off and landing and both aircraft were performing commercial flights.
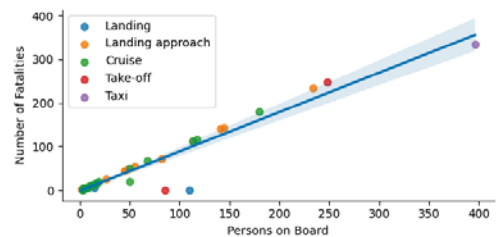

Fig. 6. Number of fatalities per number of persons on board.

3.5. *Forecast incidents due to crew communication problems*

Using information provided by the Aviation Safety Reporting System (ASRS), a database of aviation incidents that have occurred since 2009 has been created. This database is maintained by NASA and the FAA , and contains thousands of voluntarily reported aviation incidents, making it

a valuable source of information for predicting future aviation incidents.

Using the ASRS database, it was found that the year 2021 had a decrease in the number of reported incidents related to crew communication problems, with 156 incidents reported. However, this was followed by a slight increase in 2022, with 155 incidents reported. The forecast for 2023 shows a further increase to 190 incidents, followed by 193 in 2024, and 196 in 2025. The year 2026 is expected to bring 200 reported incidents due to crew communication problems.

It is worth noting that the accuracy of these predictions may still be influenced by the quality and quantity of data available in the ASRS database. Nevertheless, the use of a larger sample size database can provide more reliable insights into the trends of incidents related to crew communication problems in aviation.
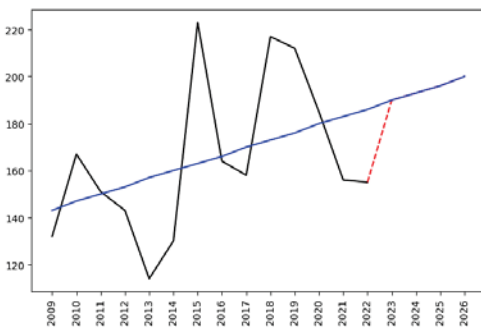

Fig. 7.   Forecast of Incidents Due to Crew Communication Problems (2009-2026) .

4. Conclusions

A statistical analysis of accidents and aviation incidents confirms the fact that communication is, in fact, one of the basic factors determining the correct functioning of aviation, including safety in the broadest sense. It has been shown that numerous errors in communication occur especially during the flight, which is largely due to errors committed in the pilot-controller relationship . Nevertheless, language problems and failure to stick to procedures also remain significant. Analysis of the created database also indicated the safest phases

of the flight, which undoubtedly include takeoff and landing, that is, situations in which pilots must be maximally focused on the activities performed and communication with the controller.

The made forecast of the number of possible aviation incidents, shows a growing trend. Aircraft incidents are recorded all over the world, and although they do not cause catastrophic consequences, consequently, ignoring them can already lead to serious aircraft accidents. That is why it is so important to rigorously follow the procedures for the application of effective and efficient communication, including their possible modification, otherwise the types of communication errors mentioned in this article will lead to an increasing number of dangerous aviation incidents in the years to come.

In view of the above, it is intended to continue the research by expanding the model for forecasting aviation incidents, taking into account the detailed analysis of data on the types of communication errors committed. Knowledge regarding the number of aviation incidents caused by crew communication problems in subsequent years will allow the implementation of preventive measures. It is expected that the created model will allow to prevent aviation incidents, which will raise the level of aviation safety and at the same time reduce financial losses for aviation companies.

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