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Analysis of Miscommunication between Pilot and Air Traffic Control (ATC) and Its Contribution to Flight Incidents

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Abstract

This study aims to analyze the forms, causes, and impacts of miscommunication between pilots and Air Traffic Controllers (ATC) on flight incidents. The research employs a qualitative descriptive design with a case study approach based on content analysis of official safety reports from KNKT, ICAO, and FAA. Data were analyzed using the Human Factors Analysis and Classification System (HFACS) framework to identify human, environmental, supervisory, and organizational factors. The results indicate that the most common types of communication errors include readback errors, hearback errors, non-standard phraseology, overlapping transmissions, and omission errors. Major contributing factors involve fatigue, high workload, frequency interference, insufficient phraseology training, and weak reporting culture. Miscommunication has been shown to directly contribute to incidents such as loss of separation, airprox, and runway incursions. Recommended mitigation efforts include scenario-based training, implementation of the Safety Management System (SMS) and Just Culture, as well as the use of digital communication technologies such as Controller Pilot Data Link Communication (CPDLC). Effective, clear, and standardized communication remains the cornerstone of aviation safety.

Keywords: Miscommunication, Pilot, Air Traffic Controller, Hfacs, Aviation Safety

INTRODUCTION

Aviation safety is the top priority in modern aviation. Along with the increasing frequency of flights and the complexity of airspace, the role of the Air Traffic Controller (ATC) has become increasingly crucial in maintaining order, efficiency, and safety in air traffic. One of the fundamental aspects that connects the pilot and ATC is communication. Effective and accurate communication is not merely an operational routine but a vital system that determines the safety of thousands of lives in the air every day.

In the air traffic control system, communication between pilots and ATC is conducted via VHF (Very High Frequency) radio using standardized phraseology established by the International Civil Aviation Organization (ICAO). This phraseology serves to minimize ambiguity, accelerate understanding, and ensure that every instruction, information, and clarification is received and responded to correctly by both parties. However, in practice, deviations often occur in the form of communication errors (miscommunication) that can potentially lead to flight incidents or even accidents (Braithwaite & Peter Brooker, 2007).

According to data from ICAO and the Federal Aviation Administration (FAA), around 75% of aviation accidents and incidents worldwide involve human factors, and among those numbers, nearly one-third are caused by communication errors between pilots and ATC. These communication errors may include hearback errors, readback errors, use of non-standard terminology, frequency interference, or misinterpretation of instructions. Even minor communication errors such as a one-digit discrepancy in altitude or frequency can be fatal in dense and dynamic air traffic conditions (Drury, 2000).

One of the most well-known examples that illustrates the fatal impact of miscommunication is the Tenerife Airport Disaster (1977). In this accident, two Boeing 747 aircraft collided on the runway due to miscommunication between the pilot and ATC regarding

takeoff clearance. A misinterpretation of the phrase *"cleared for takeoff"*, delivered ambiguously, led to 583 fatalities. This tragedy became a major lesson in aviation that communication is not only a technical aspect but also a highly complex psychological, linguistic, and cognitive process (Kobaszyńska-Twardowska et al., 2023).

In Indonesia, cases of miscommunication between ATC and pilots have also been identified in several reports by the National Transportation Safety Committee (KNKT). Several flight incidents that occurred within the Jakarta Flight Information Region (FIR) were caused by loss of separation, airprox (near mid-air collision), and runway incursions, some of which originated from ineffective communication (Sazpah et al., 2020). In several cases, there was a mix of English and Indonesian, incorrect intonation, and readbacks that were not properly confirmed by ATC or the pilot. This condition shows that although ICAO's standard phraseology has been globally established, its field implementation still requires continuous monitoring and evaluation.

In the context of human factors, the Human Factors Analysis and Classification System (HFACS) model provides a relevant analytical framework to understand the contribution of human errors to aviation incidents. This model classifies human error factors into four main levels: unsafe acts, preconditions for unsafe acts, unsafe supervision, and organizational influences (Lyu et al., 2019). Miscommunication between pilots and ATC generally falls under unsafe acts, but its root causes often lie deeper, such as in working conditions, training, or organizational culture.

In addition to HFACS, the concepts of Crew Resource Management (CRM) and the Air Traffic Management (ATM) Communication Model also emphasize the importance of effective coordination and communication in preventing incidents. CRM was initially developed to enhance cooperation among cockpit crew members but is now also applied to pilot ATC interactions. Through CRM training and ATC communication workshops, both parties are expected to build shared situational awareness, mutual understanding, and optimized feedback loops in every communication process.

Modern technology has actually helped reduce communication errors through the implementation of Controller Pilot Data Link Communication (CPDLC) and Automatic Dependent Surveillance -Broadcast (ADS-B) (Madeira et al., 2021). However, in reality, verbal communication remains the main medium in air traffic, particularly in airspace regions with limited infrastructure, such as certain areas of Indonesia. This makes research on miscommunication still relevant and important, especially to explore the specific causal factors occurring in the operational context of ATC in Indonesia.

Furthermore, the implementation of the Safety Management System (SMS) mandated by ICAO Annex 19 encourages every air navigation service provider to report and analyze every communication incident. In the context of safety culture, the Just Culture approach is essential so that communication errors can be reported without fear of punishment (Stroeve et al., 2023). Thus, organizations can learn from mistakes to improve systems rather than merely blaming individuals.

This research remains relevant because there is still a gap between theory and practice in the implementation of phraseology and operational communication. Many ATC and pilots understand the importance of standard communication, but factors such as local habits, work pressure, training limitations, and lack of regular evaluation continue to make miscommunication risks high. Through an in-depth analysis of real cases and incident reports, this research is expected to provide a comprehensive overview of the types of communication errors, their causal factors, and their impacts on aviation safety.

RESEARCH METHODS

Research Design

This study employs a qualitative descriptive method with a case study approach. The purpose is to describe and analyze the forms, causes, and impacts of miscommunication between pilots and Air Traffic Controllers (ATC) on flight incidents. The analysis is based on the Human Factors Analysis and Classification System (HFACS) framework to understand the relationship between human, environmental, and organizational factors contributing to communication errors.

Subjects and Materials

The subjects of this study include communication data between pilots and ATC, especially from aviation incident reports issued by the National Transportation Safety Committee (KNKT). Supporting data were obtained from ICAO and FAA documents, as well as literature and journals discussing aviation communication and safety.

Data Collection Technique

Data were collected through document analysis and literature review. The researcher examined incident reports to identify forms of communication errors such as readback errors, hearback errors, and non-standard phraseology based on ICAO standards. The data were further supported by relevant previous studies and theoretical references.

Data Analysis Technique

Data were analyzed using content analysis with a qualitative descriptive approach. Each finding was classified into four categories based on the HFACS model: unsafe acts, preconditions for unsafe acts, unsafe supervision, and organizational influences. The results are presented descriptively to illustrate the patterns of communication errors and their relation to flight incidents.

Data Validity

Data validity was ensured through source triangulation by comparing findings from KNKT reports, academic literature, and official international documents such as ICAO.

RESULT AND DISCUSSION

Forms and Types of Communication Errors between Pilot and Air Traffic Controller (ATC)

The analysis shows that communication errors (miscommunication) between pilots and Air Traffic Controllers (ATC) are recurring phenomena in aviation operations, both nationally and internationally. Based on the classification from the U.S. Department of Transportation (1998), the most frequent types of miscommunication in ATC pilot interactions can be categorized into five main types:

1. Readback Error an error that occurs when the pilot incorrectly repeats an ATC instruction. For example, when ATC gives the instruction “descend to flight level two five zero,” but the pilot repeats it as “two one zero.” This mistake has the potential to cause a loss of separation if not immediately corrected by ATC.
2. Hearback Error an error made by ATC in hearing or understanding the pilot’s readback. This often occurs due to high communication workload or radio frequency interference.
3. Ambiguity in Phraseology the use of phrases inconsistent with the Standard ICAO Phraseology (Doc 4444). For instance, ATC uses the term “continue approach,” when the actual meaning should be “cleared to land,” which has different operational implications.

4. Overlapping Transmission a condition where two or more transmissions occur simultaneously on the same frequency, resulting in incomplete messages. This often occurs at airports with high traffic density.
5. Omission Error the omission of critical information such as a call sign, altitude, or heading, which can lead to ambiguity.

Based on document reviews and KNKT reports (2021), most communication incidents in the Jakarta Flight Information Region (FIR) were caused by a combination of readback errors and the use of mixed languages (English and Indonesian) (Sazpah et al., 2020). This finding reinforces that although ICAO communication standards have been established, their implementation in the field remains inconsistent due to habitual and local contextual factors.

Factors Causing Communication Errors between Pilot and ATC

The causes of communication errors are not only derived from individual mistakes but also involve environmental, procedural, and organizational elements. Based on the analysis using the Human Factors Analysis and Classification System (HFACS) model by Wiegmann (2000), the causes of miscommunication can be explained through four main levels:

1. Unsafe Acts
   These are direct errors committed by individuals, either pilots or ATCs. Examples include:

a. ATC incorrectly stating the altitude or frequency.
b. Pilot failing to perform an accurate readback.
   Such errors often occur due to fatigue, loss of concentration, or rapid communication under time pressure.

2. Preconditions for Unsafe Acts
   This factor involves the physical and mental condition of workers. Both ATC and pilots are exposed to high stress and workload levels. Fatigue reduces active listening ability by up to 20% and slows down response times by 0.5 seconds, which is significant in high-speed communication.
3. Unsafe Supervision
   Communication errors often occur due to insufficient communication training or the lack of routine phraseology evaluation. Many ATC units still do not have a continuous ICAO phraseology training program, causing repetitive errors to go undocumented and uncorrected systematically.
4. Organizational Influences A weak organizational culture that does not support error reporting also plays a major role. In many cases, ATC or pilots are reluctant to report communication errors for fear of punishment. However, under the concept of Just Culture (Howard, 2024), every mistake should be a learning opportunity, not a punishment. Organizational factors also include limited human resources and dense operational schedules that contribute to staff fatigue.

In addition to these four factors, linguistic and cultural influences also play a role. ATCs in Indonesia often use a combination of English and Indonesian, especially during ground communication. This creates ambiguity for foreign pilots who do not understand the local language and increases the risk of misinterpreting instructions.

The Impact of Communication Errors on Flight Incidents

Communication errors between ATC and pilots have a direct impact on flight incidents, particularly loss of separation, airprox, and runway incursions (U.S. Department of Transportation, 1998). Incident analyses show that the impact of communication errors depends not only on the error itself but also on:

1. Situational awareness of ATC and pilots at the time of the incident.
   For instance, in high traffic density, a small error such as a one-digit altitude difference can cause two aircraft to be on intersecting paths.

2. Reaction time between the error and correction. If ATC quickly detects a readback error and corrects it, the potential danger can be minimized. However, if the correction is delayed, the risk of incident increases.
3. Radio communication quality (signal clarity). Interference or dual frequency transmission can cause instructions to be misheard or not received clearly.

In Indonesia, based on several cases studied by Wulansari et al. (2025), loss of separation incidents were often caused by a combination of readback and hearback errors that were not reconfirmed by ATC. For example, a pilot might receive clearance to descend to FL280 instead of the intended FL260, and ATC might fail to notice the incorrect readback due to frequency interference. This situation could result in two aircraft being separated by less than 1,000 feet, violating the minimum separation standard. Thus, it can be concluded that miscommunication is not merely a secondary cause but a primary causal factor in several flight incidents, especially in high-density airspace such as the Jakarta FIR.

Prevention Efforts and Mitigation Strategies

To minimize communication errors and their impact on aviation safety, several preventive strategies can be implemented:

1. Improvement of Communication Training ATC and pilots should undergo regular ICAO-standard phraseology training, including scenario-based training to simulate real communication situations.
2. Implementation of Safety Management System (SMS) Through SMS, every air navigation unit can conduct reporting and analysis of communication errors to prevent recurrence. The Safety Promotion pillar in SMS also strengthens safe communication culture and awareness of phraseology standards.
3. Implementation of the Just Culture Concept A fair safety culture allows ATC and pilots to report communication errors without fear of punishment. This approach enables organizations to identify error patterns and improve work systems rather than merely assigning blame.
4. Utilization of Digital Communication Technologies (CPDLC and ADS-B) In high-traffic airspace, the use of Controller-Pilot Data Link Communication (CPDLC) can reduce the risk of verbal miscommunication by converting it into automated data messages.
5. Monitoring and Auditing Operational Communication Radio communication recordings can be analyzed periodically to evaluate compliance with ICAO-standard phraseology. Communication audits help detect recurring error patterns and identify areas that require additional training.

From the analysis above, it can be concluded that communication errors between pilots and ATC are not solely the result of individual mistakes but the outcome of a complex interaction between human, system, and organizational factors. Although aviation technology and safety procedures have advanced significantly, human and linguistic aspects remain the weakest points in air traffic control systems. Factors such as fatigue, high workload, and non-standard phraseology continue to be the main causes of miscommunication. Therefore, improvements in aviation safety cannot be achieved solely through technological updates but must also include the strengthening of safe communication culture, continuous training, and transparent reporting systems.

CONCLUSION

Based on the results of the research and the discussion conducted, it can be concluded that miscommunication between pilots and Air Traffic Controllers (ATC) plays a highly significant role in the occurrence of flight incidents in aviation. Communication, which should serve as a vital link between the two main parties in the air traffic control system, often becomes a weak point that triggers various incidents. The most common forms of communication errors include readback errors, hearback errors, the use of non-standard phraseology, overlapping transmissions, and the omission of essential messages (omission errors). Even minor mistakes such as incorrect altitude, frequency, or maneuver clearance instructions can have major consequences for flight safety, especially in busy and dynamic air traffic conditions.

The causes of communication errors cannot be separated from human factors, technology, and organizational aspects. According to the Human Factors Analysis and Classification System (HFACS) framework, such errors do not originate solely from individuals but also from environmental conditions, psychological workload, weak supervision, and organizational cultures that do not support open error reporting. Fatigue, high work pressure, environmental disturbances, and limited phraseology training are dominant factors that reduce communication accuracy between pilots and ATC.

These communication errors have been proven to directly contribute to various flight incidents such as loss of separation, airprox, and runway incursions. Data from ICAO and KNKT show that approximately one-third of aviation incidents worldwide involve elements of miscommunication. In Indonesia, miscommunication cases often arise from mixed language use (English and Indonesian), lack of readback confirmation, and inaccuracies in the application of ICAO standard phraseology. Therefore, miscommunication should not be regarded as a minor error but rather as a critical factor that directly impacts flight safety.

Hence, improving aviation safety must be carried out through a systemic and comprehensive approach. The implementation of the Safety Management System (SMS) and *Just Culture* is crucial in fostering an open error-reporting culture without fear of punishment. Additionally, scenario-based communication training for ATC and pilots should be strengthened to realistically simulate emergency and operational pressure situations. The adoption of digital communication technologies such as Controller–Pilot Data Link Communication (CPDLC) and ADS-B–based surveillance systems can also help reduce reliance on verbal communication and minimize potential errors caused by frequency interference.

Overall, it can be concluded that effective, clear, and standardized communication between ATC and pilots forms the foundation of aviation safety. Strengthening communication competence, implementing ICAO standard phraseology, and enhancing situational awareness are key steps to reducing communication error risks in the future. Through the synergy of training, technology, and a robust safety culture, it is expected that Indonesia's aviation sector will continue to improve its operational quality and safety in line with international standards.

REFERENCES

Braithwaite Peter Brooker, G. (2007). *Air Traffic Control Radiotelephony Safety: Investigating the English Second Language Users' Perspective*.

Drury, C. G. (2000). *Human Factors in Aircraft Maintenance*.

Howard, R. , & D. J. B. (2024). Human Factors and Principles of Patient Safety: The James Reason Model. *Principles of Perioperative Safety and Efficiency*.

Kobaszyńska-Twardowska, A., Łukasiewicz, J., & Łopatka, P. (2023). Quantitative analysis of aviation incidents: A comprehensive study on bird strikes and safety improvement

opportunities. *Journal of Sustainable Development of Transport and Logistics*, *8*(2), 229–238. https://doi.org/10.14254/jsdtl.2023.8-2.17

Lyu, T., Song, W., & Du, K. (2019). Human factors analysis of air traffc safety based on hfacs-bn model. *Applied Sciences (Switzerland)*, *9*(23). https://doi.org/10.3390/app9235049

Madeira, T., Melício, R., Valério, D., & Santos, L. (2021). Machine learning and natural language processing for prediction of human factors in aviation incident reports. *Aerospace*, *8*(2), 1–18. https://doi.org/10.3390/aerospace8020047

Sazpah, W., Wantu, F., & Kasim, N. M. (2020). *TANGGUNG JAWAB KORPORASI BOEING COMPANY ATAS KECELAKAAN PESAWAT DI WILAYAH INDONESIA*. https://nasional.kompas.com

Stroeve, S., Kirwan, B., Turan, O., Kurt, R. E., van Doorn, B., Save, L., Jonk, P., Navas de Maya, B., Kilner, A., Verhoeven, R., Farag, Y. B. A., Demiral, A., Bettignies-Thiebaux, B., de Wolff, L., de Vries, V., Ahn, S. Il, & Pozzi, S. (2023). SHIELD Human Factors Taxonomy and Database for Learning from Aviation and Maritime Safety Occurrences. *Safety*, *9*(1). https://doi.org/10.3390/safety9010014

U.S Department of Transportation. (1998). *Pilot-Controller Communication Errors: An Analysis of Aviation Safety Reporting System (ASRS) Reports*.

Wiegmann, S. A. (2000). *The Human Factors Analysis and Classification System--HFACS*.

Wulansari, I., Tumpu, M., Ampangallo, B. A., Londongsalu, J., Padang, I., Sahari, D., Matana, H., Abdillah Takdir, R., & Radjawane, L. E. (2025). *KESELAMATAN TRANSPORTASI Penulis ARSY MEDIA*. Arsy Media. https://arsymedia.com