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Barriers to in-flight communication effectiveness: a qualitative inquiry with pilots in Türkiye

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Abstract: Effective communication is crucial for pilots, ensuring flight safety, teamwork, and informed decision-making. Piloting presents significant challenges due to high stress, rapid decision-making, and extensive training. Clear communication in flight operations reduces errors, enhances crew performance, and improves responses to critical situations. This study explores factors that hinder effective cockpit communication through semi-structured interviews with 14 pilots. Findings reveal key barriers: personal factors (stress, fatigue, emotional regulation), environmental challenges (cockpit noise, adverse weather), language barriers among non-native English speakers, and hierarchical differences limiting open communication. Additionally, perceptual differences in attitudes, values, and non-verbal cues further complicate interactions, affecting situational awareness and flight safety. Addressing these barriers is essential to improving crew resource management (CRM) and operational efficiency. The study emphasises the need for enhanced training and policies to ensure effective pilot communication, contributing to aviation safety.

Keywords: effective communication; flight safety; aviation communication; pilot communication; Türkiye.

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1 Introduction

The process of communication, where the information being conveyed is understood by both the sender and the receiver, is a well-researched concept in the field of aviation. In flight operations, it is crucial that messages are accurately shared among flight crews. The sharing of information from the cabin to the cockpit and the exchange of all flight-related information between the pilot flying (PF) and the pilot monitoring (PM) in the cockpit is of paramount importance. Therefore, communication is a critical aspect of ensuring the safety of any flight. In January 2020, the International Air Transport Association [IATA, 2020 as cited in Çeken and Aktaş, (2022), p.176] emphasised the importance of communication in aviation as follows:

“Information transfer in communication should enhance situational awareness, allow problem-solving among team members, and benefit effective decision-making processes. Inadequate communication practices can lead to a loss of situational awareness among team members, undermine teamwork, and result in extremely poor decisions, leading to serious and fatal accidents.”

Information transfer between flight crew members, accepting commands, conducting briefings, carrying out instructions, and asking questions are all significant aspects of communication (Sexton and Helmreich, 2000). Effective communication in the cockpit is a prerequisite for safety (Smith-Christensen and Duckert, 1995). Kanki and Palmer (1993) also emphasise the importance of communication in aviation safety. As seen in the existing literature, many authors have highlighted the importance of communication for flight safety from various perspectives. This study aims to provide new perspectives on overcoming communication barriers in the aviation industry by deeply examining the specific challenges faced in communication among pilots and the impact of these challenges on flight safety. Our study particularly focuses on areas such as personal factors, environmental conditions, non-verbal communication, and feedback mechanisms, which have not been sufficiently addressed in previous research, thereby addressing the importance of effective communication among pilots in a broader context. This approach will form the basis for developing strategies towards communication practice and policies in the aviation industry, thus contributing to the enhancement of flight safety and operational efficiency. Consequently, it is essential to appropriately utilise communication skills for the effective and safe conduct of flight operations.

1.1 Problem

The problem addressed by this study is to examine the specific challenges pilots face in achieving effective communication within the aviation industry and the resulting impacts on flight safety. Although various studies have explored communication barriers, there remains a need for in-depth analysis of these challenges and their direct effects on pilot interactions. This research aims to fill this gap by evaluating the key obstacles and proposing targeted strategies to improve communication practices, thereby enhancing overall safety in aviation. By considering the risks of errors, management of potential threats, declines in crew performance, and ineffective sharing of critical information that may arise when healthy communication among pilots is not established, this study examines the potential impacts of this problem on aviation safety. Thus, this study aims to provide new perspectives on overcoming communication barriers and enhancing flight safety in the aviation industry.

1.2 Purpose

The purpose of this research is to address the importance of effective communication among pilots in the aviation industry and to identify the factors that hinder this communication. This study aims to determine the factors that impede communication among pilots during flights and to evaluate the impact of these factors on flight safety.

Specific research questions to be investigated are indicated below.

1.3 Research questions

This study aims to address the following research questions to comprehensively explore the barriers to effective communication in the aviation industry and their impact on flight safety:

- 1 What are the primary communication challenges faced by pilots during flight operations?
- 2 In what ways does inadequate communication affect flight safety?
- 3 Which factors contribute most significantly to the prevention of effective communication among pilots?
- 4 How does the use of inappropriate communication methods lead to anxiety, tension, or conflict in the cockpit?
- 5 To what extent do cultural differences influence communication effectiveness in aviation settings?
- 6 What is the role of crew resource management (CRM) training in enhancing pilots' communication skills?
- 7 How do fatigue and stress impact pilots' ability to communicate effectively and make critical decisions?

2 Literature review

The aviation industry is a highly complex field that mandates the maintenance of safety standards and operational efficiency. In this sector, effective communication, especially among pilots, plays a critical role in ensuring flight safety. Communication is the process of sending a message from the sender to the receiver through appropriate communication channels. Often, it is assumed that the message sent has been received by the recipient; however, the use of incorrect communication tools, the recipient not being ready to receive the message, the message not being prepared in an understandable manner, and the message not being sent appropriately to its purpose can hinder effective communication.

CRM training contributes to better communication. Some recommended methods to improve communication are listed below.

Effective communication in aviation requires more than merely transmitting a message; it is essential to ensure that the message is accurately received and understood as intended. Active listening plays a crucial role in this process, as it involves fully concentrating on the speaker, avoiding distractions, and engaging with the message. Additionally, non-verbal cues, such as body movements, facial expressions, and emotional signals, should be observed to enhance the comprehension of the communicated message. When misunderstandings occur, it is important to address them explicitly and clarify or restate the message to ensure accuracy. Communication should be conducted using simple, clear, and concise language, facilitating a mutual understanding among all parties involved. Whenever feasible, face-to-face communication is preferable; however, in situations where this is not possible, such as pilot-controller interactions, it is crucial to avoid non-standard phrasing and uphold a professional tone. Furthermore, conflict should be minimised by focusing on the content of the message rather than personal issues, thereby preventing unnecessary tension. Feedback should be constructive, aimed at improving communication practices, and should be consistently provided by both the sender and the receiver to foster an open exchange of information.

These strategies aim to enhance communication practices and policies within the aviation industry, thereby contributing to the enhancement of flight safety and operational efficiency.

Regarding CRM, there are numerous factors that hinder communication. In their study, Oskamp and Granrose (1997) examine intercultural communication barriers and specifically the tension between conveying flight safety-related information and saving face. The study emphasises varying degrees of politeness among pilots, influenced by factors such as status differences, familiarity and the burden of discourse. While highlighting the importance of effective communication, it is noted that captains often use more politeness towards first officers, which can sometimes undermine the seriousness with which they are taken.

In another study, Mirković and Simic (2019) categorise communication failures into several categories. These include direct language barriers that hinder message transmission, situations where communication is sufficient but context is not clearly expressed, resulting in the received message not being the intended one, and instances where the message is understood as intended but not acted upon adequately due to cultural factors. The research underscores that a lack of effective communication among flight crews restricts the flow of critical safety-related information. The article also

clarifies experts' recommendations for reducing language barriers that, despite modern technology, continue to play a significant role in fatal accidents [Mirkovič and Simic, (2019), pp.1131–1135].

Hall's (2018) 'Survey of flight instructors' experiences in communication training' conducted a survey to understand the communication training experiences of flight instructors at a university. This study provides insights into the communication skills acquired by flight instructors through flight training, lessons and daily interactions. Hall (2018) evaluates the current state of communication training and suggests potential areas for future research. However, the scope of the study is limited to flight instructors at one university and focuses on the specific challenges of effective communication with students during flight training.

Peksatici's (2018) 'Crew resource management (CRM) and cultural differences among cockpit crew – the case of Turkey' deeply examines the impact of cultural differences on CRM among cockpit crews in Turkey. This study makes a significant contribution by emphasising the importance of CRM practices in the cultural context and the role of effective communication among pilots in the aviation sector. However, it should be noted that communication barriers are not solely due to cultural differences, and communication issues in the aviation sector need to be examined from a much broader perspective. In this context, our study aims to address communication barriers among pilots from a much wider framework. Beyond cultural differences, various dimensions of communication barriers, such as personal factors, language barriers, environmental factors, non-verbal communication, hierarchical structures, and differences in feedback practices, will be comprehensively examined. This expanded approach will facilitate a better understanding of the importance of communication in the aviation sector and enable the development of strategies to enhance the effectiveness of CRM practices.

In the aviation industry, effective communication is paramount for ensuring safety and operational efficiency. Recent studies have delved into various aspects of communication within this sector. For instance, Alharasees et al. (2023, pp.379–388) investigated the impact of critical factors on the rate of misunderstandings in aviation communication. Their findings highlight that non-native English-speaking operators are more prone to communication errors, which can lead to potentially hazardous situations. This underscores the necessity for enhanced language training and cultural awareness programmes to mitigate such risks.

In the aviation industry, it is generally accepted that communication among pilots is critically important for flight safety and operational efficiency. Existing literature has focused on various communication barriers such as cultural differences, language barriers and CRM training. However, these studies have typically focused on specific communication barriers and have been limited in comprehensively addressing the specific challenges in communication among pilots and their direct effects on flight safety.

3 Methodology

3.1 Measures

This study employed semi-structured interviews to capture the experiences, insights, and perceptions of pilots regarding communication challenges in aviation. The interview questions were developed based on a thorough review of existing literature, with a focus on key themes such as communication barriers, the role of CRM, cultural differences, and the effects of stress and fatigue on communication. These themes guided the creation of open-ended questions designed to encourage participants to provide concrete examples from their professional experiences and elaborate on the barriers they encountered as well as the strategies they used to overcome them. Prior to the main study, the interview questions were reviewed and refined with the help of expert feedback to ensure clarity and alignment with the research objectives. The interviews were conducted face-to-face with 14 pilots, each with varying levels of experience. Participants were encouraged to share their views on CRM training and cultural differences and their impact on communication dynamics during flight operations. Data from these interviews were transcribed and analysed using qualitative thematic analysis to identify common themes and patterns related to communication barriers and strategies in the aviation sector.

3.2 Participants

The study included 14 pilots with different levels of experience. Participants were selected to include pilots with experience in both domestic and international flights, operating aircraft such as Boeing 787-9 Dreamliner, Boeing 777-300, Boeing B737-800, Boeing 737-900ER, Boeing 737-800, Airbus A350-900, Airbus A330-300, Airbus A330-200, Airbus A321neo, Airbus A321-200, Airbus A320-200 and Airbus A319-132/100. Interviewees were selected using snowball sampling.

3.3 Procedure and analysis

The research will be conducted through semi-structured in-depth interviews (Neuman, 2014). Semi-structured interviews allow for the investigation of the range and significance of pilots' ideas, and the importance of effective communication and flight experience. Semi-structured interviews were undertaken with 14 pilots. Interviews took place face-to-face or via internet video link, were audio-recorded, and then promptly transcribed. The duration of the interviews will vary between 60 and 90 minutes, and the confidentiality of participants will be fully protected. The interviews were conducted in Turkish and later translated into English for analysis. Interviewing allowed the production of data on aviation narratives and on how respondents evaluated their flight experiences.

Interview data will be collected by recording audio and then transcribing it. Data analysis will be conducted using qualitative methods (Neuman, 2014). During this process, the interview transcripts will be carefully examined to identify common themes and patterns related to communication barriers, effective communication strategies, and their impact on flight safety. In the analysis phase, interpretations of participants' statements will be made in accordance with qualitative research ethics.

4 Findings

4.1 Theme 1: personal factors (stress, fatigue and other psychological factors)

The impact of personal factors on communication among pilots in aviation is a deep and multidimensional issue. Human factors, especially stress, fatigue, and other psychological factors, can significantly affect pilots' cognitive and communication abilities, directly impacting air traffic safety. Stress, particularly in high-traffic control areas or during unexpected situations and emergencies, can distract pilots and negatively influence their decision-making processes. This can lead to the transmission of incorrect or incomplete information, resulting in critical communication errors and safety concerns. As one captain pilot noted:

“As a pilot, emotional intelligence is a crucial part of crew resource management (CRM), especially in high-stress situations. Understanding and empathizing with the workload and stress of my team members helps us support each other effectively.” (P3)

Emotional intelligence plays a critical role in stressful environments:

“Emotional intelligence is indeed pivotal in coping with stressful, high-workload, and abnormal situations I face as a pilot. The key lies in managing my emotions and understanding the emotional states of my team members to respond appropriately. For instance, during an emergency procedure due to a technical malfunction, it was vital to maintain calmness, keep morale high within the team, and ensure my colleagues stayed composed. By controlling my emotions, I managed the situation as if it were a routine, allowing the team to focus on their roles and contribute to decision-making processes as needed.” (P14)

Fatigue, which can result from long-haul flights, can slow pilots' reaction times, lead to memory lapses, poor judgement and decreased situational awareness. A fatigued pilot might misinterpret instructions or fail to convey necessary information accurately. Additionally, sleep deprivation and irregular working hours can impair pilots' concentration and communication skills, leading to ineffective communication during flights. Pilots expressed how fatigue affects their communication skills:

“Fatigue reduces perception and situational awareness. Consequently, I would say that there is a relative decrease in communication. In such cases, I prefer to increase situational awareness and communicate more with my team member, considering that they might also be tired.” (P4)

“Fatigue changes my communication. When I feel tired, I generally speak less. Due to increased chances of misunderstanding or not understanding at all, I stick to operationally focused and unambiguous standard callouts. I avoid discussing non-operational matters to prevent distractions and refrain from personal conversations.” (P5)

“Long flights can be really challenging. At the end of the day, we are all human, and fatigue inevitably affects us too. When we are tired, the atmosphere in the cockpit changes. Conversations decrease, and everyone focuses more on their tasks. During such times, we choose our words more carefully and avoid unnecessary chatter. That's why, when we feel tired, we strive to keep communication as clear and direct as possible. We adhere to the 'short and concise' principle. This helps prevent misunderstandings, especially when sharing important information.” (P1)

“We pay extra attention to each other because fatigue can lead to mistakes. For instance, while one of us double-checks something, the other also reviews it. This way, if one misses something, the other can catch it. We manage resources wisely. Let’s say one of us feels extremely tired. In that case, the other takes on more tasks, allowing the tired person to rest a bit. This means safety is always prioritized.” (P14)

Among other psychological factors are lack of motivation, burnout syndrome and individual stress coping mechanisms. Communication among pilots is also influenced by group dynamics and team cohesion within the cabin. Negative team dynamics can lead to conflicts and misunderstandings. Conversely, supportive communication within the team and effective conflict resolution mechanisms can optimise communication even in stressful situations. A captain pilot underlined the following:

“It is crucial for pilots to be trained in maintaining a healthy work environment and workload management, cognitive and psychological resilience, stress management, and combating fatigue. In the aviation industry, managing human factors should be viewed not only as part of risk management and safety procedures but also as a fundamental element of pilot training and certification. A comprehensive approach focusing on human factors is essential to support safe and effective communication among pilots.” (P1)

4.2 Theme 2: environmental factors (noise)

Environmental factors contributing to communication barriers encompass external influences that affect the flow of communication and are often beyond the pilots’ control. These factors can significantly reduce the quality and effectiveness of communication in aviation. Environmental factors include cockpit noise, weather conditions, interference from electronic devices, and the physical state of communication equipment. Each of these elements can directly impact pilots’ ability to communicate effectively. For example, cockpit noise from engine sounds, airflow, and other external noises encountered during flight can disrupt communication. High noise levels can make it difficult for pilots to hear each other, potentially leading to missed critical information during radio transmissions. Additionally, the multitude of auditory warning systems (e.g., approach warning systems) can distract pilots and cause them to miss important communications. A first officer noted:

“To mitigate the negative effects of noise and other distractions, new | systems have been developed. Using written communication instead of verbal communication helps reduce these barriers.” (P2)

Weather conditions, particularly adverse weather (e.g., heavy clouds, storms or turbulence), can further complicate communication between pilots. In such situations, pilots need to focus more on controlling the aircraft rather than on communication, which can reduce the clarity and effectiveness of their exchanges.

Interference from electronic devices and frequency mix-ups can also create issues in pilot communication. Modern cockpits contain numerous avionics devices, and the electromagnetic interference from these devices can cause frequency disruptions and communication errors. The physical condition of communication equipment, such as outdated or poorly maintained communication tools, can impede effective communication among pilots. For instance, malfunctioning radio transceivers or

inadequately working headsets and microphones can prevent messages from being correctly received and transmitted.

“Our aircraft is generally noisy and exhausting. Most distractions, other than malfunctions, are external. For example, ATC communications, cabin crew calls, etc. When I feel uncomfortable, I use my headset to suppress external noise and manage task segregation, ensuring ATC communications and cabin calls are handled separately. Proper task management (PF/PM), headset usage, and standard phraseology provide solutions.” (P5)

“Airplane manufacturers do everything to reduce external noise in the cockpit. Newer aircraft are quieter than older ones. Continuous engine noise during long flights can be bothersome for pilots, even causing fatigue. We avoid unnecessary conversations below 10,000 feet.” (P7)

“The mentioned noise and other distractions are inversely proportional to language barriers. Based on my experience, these factors distract focus and make it difficult to understand and comprehend what is being said. I don’t make extra efforts for sterile cockpit procedures. The existing rules already provide this environment as part of our job. However, as experience grows, a captain can quickly determine when and what to discuss or avoid discussing. Following standard communication procedures is crucial.” (P13)

“Noise is definitely present, but you get used to it. Our headsets and microphones are quite good, keeping communication healthy. As for the sterile cockpit rule, while its purpose is to enhance flight safety, it is not always adhered to 100%. We are human, and sometimes it is challenging to follow the rules, especially during long and monotonous flights, where we might engage in conversations that could distract us.” (P14)

Understanding and addressing these environmental factors is crucial for improving communication among pilots and enhancing aviation safety. For instance, steps can be taken such as using high-quality headset systems to reduce cockpit noise, regularly maintaining communication equipment, and developing weather-resistant communication systems. Additionally, pilots’ abilities to cope with such environmental factors can be enhanced through simulation training. Consequently, reducing or managing these environmental factors is vital to ensure clarity and accuracy in communication among pilots.

4.3 Theme 3: language barriers (differences in native languages or dialects)

For over half a century, English has been the cornerstone of international communication in aviation, serving as the key medium for interactions between pilots and control towers. This role of English has been reinforced by the regulations established by the International Civil Aviation Organization (ICAO), which aim to eliminate ambiguity and support a clear and precise flow of communication. This set of rules promotes a more understandable and standardised communication language among aviation professionals worldwide, prioritising safety in international air traffic. Language barriers can complicate communication between air traffic controllers and pilots. For instance, differences in language proficiency, especially during emergencies or complex air traffic scenarios, can lead to misinterpretation of crucial instructions. In this context, air traffic controllers and pilots are expected to achieve a certain level of proficiency in English used in international aviation and obtain certifications that document their competency.

Non-native English speakers may face various challenges and errors when using English as a second language.

Overcoming language barriers involves correctly understanding and using technical terms and specific expressions. In aviation, especially, technical and operational terms must adhere to an international standard. However, due to linguistic diversity, some operators might misinterpret these terms according to their dialects or language structures. This can result in misunderstandings between air traffic controllers and pilots, and even increase safety risks. Additionally, native English speakers might use local jargon, idioms, and various dialects, leading to communication that deviates from the standard. This departure from standardisation can cause misunderstandings in communication.

“Language is the most critical tool used in verbal communication. As is well known, the most effective language for communication is one’s native language. However, this is not always the case in aviation, as aviation professionals are required to have a certain level of proficiency in English to perform their duties. For instance, a ground operations officer must know English to communicate with a foreign flight crew. Additionally, pilots who fly internationally must pass ICAO’s language proficiency exams. Using standard terms and preferring simple communication in international settings facilitates easier communication. CRM training further supports better communication.” (P10)

“Regarding language barriers, English is the standard in aviation. However, it’s not everyone’s native language. Sometimes, it can be hard to understand. In such situations, we try to speak more slowly and clearly. If we don’t fully understand something, we don’t hesitate to ask again. After all, safety is the most important thing. The fact that not everyone speaks English at the same level can make communication really difficult in some situations. Especially in emergencies, when every second counts, such communication issues can increase the risk.” (P14)

An effective communication hierarchy is critical to ensure the accurate flow of information and to empower personnel at all levels to report issues and observations. In the aviation sector, it is essential to promote transparency and openness in inter-team communication to overcome differences in rank and authority. This approach enables all operational personnel to feel more confident in reporting encountered issues and proposing solutions.

Safety-focused programmes in aviation encourage team members to take a proactive role in identifying and addressing any safety deficiencies or operational errors they encounter. For example, under safety management systems (SMS), employees are encouraged to report any observed safety risks. SMS and similar frameworks allow employees at all levels to contribute to the safety culture, overcoming hierarchical limitations.

SMS in aviation represent a comprehensive and systematic approach to managing safety risks. As detailed by the Federal Aviation Administration (FAA), SMS encompasses structured processes, practices, and policies to manage safety risks, giving them the same priority as other key business processes. The primary components of an SMS include safety policy, safety risk management, safety assurance and safety promotion. These components work together to ensure a proactive approach to risk management and highlight the organisation’s role in accident prevention. Specifically, safety assurance processes provide structured tools that enhance confidence in safety

controls, facilitate effective information sharing, and support a robust safety culture within the aviation sector (<https://www.faa.gov/about/initiatives/sms/explained>).

In this context, flight safety training not only teaches standard operating procedures (SOPs) but also emphasises the importance of an environment where all team members can voice their concerns. These trainings encourage every team member, regardless of rank or position, to speak up about their observations and concerns, thereby enhancing operational transparency and team collaboration.

Another example is encouraging equal participation of all team members during operational briefings. In these meetings, everyone's opinions are considered, which helps overcome hesitations due to hierarchical barriers and fosters a team spirit where everyone's contribution is valued.

In conclusion, to overcome the communication barriers that hierarchical structures might impose, the aviation industry must continuously recognise and address these barriers. Especially in situations that can directly impact flight safety, establishing and maintaining open and transparent communication channels is essential for effective risk assessment and crisis management. To achieve this goal, training programmes and operational processes should be designed to support active participation from personnel at all levels.

4.4 Theme 4: perceptual differences (personality, attitudes, values, emotions)

Perceptual differences are among the significant psychological and social factors affecting communication among pilots in aviation. Perception defines how individuals see and understand the world and how these views are reflected in their behaviours. In the context of communication barriers, perceptual differences can be explained through factors such as personality, attitudes, values and emotions.

Personality is the unique combination of an individual's emotional, cognitive, and behavioural patterns that tend to remain stable over time and manifest in different social and communication contexts. From a communication perspective, personality is a fundamental factor determining how an individual interacts with others, encodes, and decodes messages [Bowers, (1973), p.307; John, (1990), pp.66–100].

The consistency in an individual's communication and behaviour can be seen as a reflection of their personality traits. For example, a person who is naturally empathetic and supportive in communication may be seen as reflecting their personality. Similarly, reactions in conflict situations, communication styles under stress, and approaches to processing information highlight the role of personality in communication. Academic studies often analyse personality using the big five model, which includes traits such as openness, conscientiousness, extraversion, agreeableness and neuroticism. This model focuses on how these traits influence communication style and collaboration tendencies. Understanding the relationship between personality and communication can significantly enhance individuals' effectiveness in areas such as teamwork and leadership.

Personality encompasses the emotional, cognitive, and behavioural characteristics of individuals. It influences how a person behaves in communication, interprets messages, and responds under stress. In short, personality can be defined as a set of stable traits that shape an individual's behaviours, motivations, and communication style in the long-term. For example, a pilot with a meticulous and systematic personality might process instructions carefully and methodically during an emergency.

Attitude refers to individuals' learned tendencies and consistent behavioural responses toward a specific object, person, group, event, or idea. Attitudes are personal approaches and reactions developed towards a particular subject, person or situation. This can range from a concrete phenomenon like an annoying pest to broad and abstract ideologies such as capitalism or communism (Hanel et al., 2021). In a communication context, an individual's attitude affects how they perceive, believe and subsequently communicate. Attitude in communication encompasses various factors from non-verbal cues to verbal statements and the overall tone of interaction. In communication among pilots and other aviation professionals, attitude can be particularly influential on critical issues like safety protocols and operational procedures. For example, pilots with a positive attitude towards a safety-related change or a new procedure can adapt more quickly and implement them more effectively. Conversely, pilots with a negative attitude may resist innovations or delay adopting changes, disrupting communication flow and team dynamics.

On the other hand, values are abstract ideals and principles that guide our lives; these values are both abstract and applicable to different situations. In psychology, both attitudes and values are essential constructs that are necessarily related, but there are significant differences between them. Attitudes are specific judgements towards a particular object, whereas values are general and transcendental principles; attitudes can be both positive and negative, whereas values are generally positive; and attitudes are not as crucial to our self-concept as values are (Hanel et al., 2021).

Understanding these perceptual differences and their impact on communication is essential for promoting effective teamwork and collaboration in aviation. For example, a pilot's careful and systematic personality can ensure meticulous processing of instructions during emergencies. Similarly, positive attitudes towards safety changes can enhance the adoption of new procedures, while strong values can guide decision-making and behaviour in various operational contexts. By recognising and addressing these perceptual differences, the aviation industry can foster a more cohesive and effective communication environment among pilots, ultimately enhancing safety and operational efficiency.

"As pilots, we leverage our emotional intelligence during high-stress situations and abnormal conditions. Empathy, a critical component of crew resource management (CRM), helps us understand and support our team members' workload and stress." (P7)

"We underwent rigorous training that challenged our minds, nerves, and physical capabilities, and successfully completed it. Throughout our careers, we continuously undergo refresher training and exams. In this process, some of us have bid farewell to colleagues with tears only to fly the same day. Although this may appear emotionless from the outside, it is actually a state of emotional silence where one experiences an inner storm. In formation flying, when a colleague signals a problem with their engine, aviation teaches that the only remedy is knowledge and skill. At such moments, you realize you can prioritize your emotions. Time is crucial; in the air, we live what we must, and on the ground, we quietly deal with our emotions and fears as much as possible." (P13)

"I don't find myself experiencing emotional difficulties while working. Aviation is a field of positive science, founded on science, numbers, and rules. I can leave behind all personal challenges when I come to work. This is a personal trait, and I consider myself fortunate. When I'm at work, I stay fully

concentrated. High workload environments and abnormal situations are a significant part of our job. In my past experiences, the more familiar you are with the rules and numbers, the easier decision-making and implementation become. At that stage, personal emotions take a back seat. I believe this foundation is provided to all pilots through training.” (P5)

4.5 Theme 5: non-verbal communication (body language)

Non-verbal communication encompasses meaningful interactions between individuals using bodily movements, facial expressions, eye contact, personal space, and tone of voice, beyond the use of words. In the communication process, non-verbal signals set the emotional tone of the message, confirm or challenge the accuracy of verbal communication. This form of communication allows individuals to express their true feelings and intentions more directly and sometimes unconsciously. Academic research [Mehrabian, (1971), pp.1–149] highlights that non-verbal communication constitutes a significant portion of the overall communication effect, particularly in enhancing mutual understanding, trust and the depth of relationships. Therefore, understanding and correctly utilising non-verbal communication skills is crucial for establishing effective communication and healthy human relationships. Among pilots, especially during stressful flight situations, clear and effective non-verbal communication can strengthen team coordination and mutual understanding, thereby enhancing safety. Consequently, training pilots in non-verbal communication skills is an important aspect of improving flight safety.

“During flights, we gauge the condition of our team members through their body language and other non-verbal communication signals, thus increasing our situational awareness to correct errors caused by fatigue in emergencies or after a busy flight.” (P6)

“When I sense such a situation, I try to engage in conversation to understand the root of the problem. In non-critical phases, I opt to talk and understand, but in critical phases, I prefer to monitor the other side more and slow down operations to minimize errors. In spontaneous decisions, it feels a bit more isolating and makes it seem like decisions are taken unilaterally.” (P5)

“During the flight, we don’t rely much on body language. Verbal communication is more crucial for us. Even seemingly unnecessary situations need to be reported to the cockpit. We always thank and do not reprimand the flight crew, even if the issue seems simple and trivial.” (P7)

“Body language and other non-verbal communication signals provide us with significant insights into how aware the other person is of their actions. For instance, it’s not wrong to approach it this way: before each flight, we have briefings with our cabin crew, either in the crew rooms or on the plane. During these briefings, I first observe the captain who leads and manages the briefing. If their head is down, avoiding eye contact and just talking for the sake of talking, the captain is the biggest threat to me at that moment. I expect them to look into the eyes of the crew members, just as I do, and mentally ask, ‘Are these colleagues ready to fly? Are they alert for the flight?’ If this is not happening, I wonder if the captain is sleep-deprived or preoccupied with a problem. Can they focus on this flight and manage it safely? The same applies to the cabin crew.” (P13)

“During the flight, especially during intense moments or emergencies, the body language and other non-verbal communication signals of our team members

can provide vital information. Elements like tone of voice, eye contact, facial expressions, and body posture help me understand how a team member truly feels and perhaps the concerns they are hesitant to verbalize. Once, during a busy flight, I noticed my co-pilot seemed a bit tense. Normally, he is very calm, but that day his facial expression and changes in his tone indicated something was wrong. Avoiding eye contact and frequently looking at the control panels more than usual was a sign of his anxiety. This observation opened a door for me to talk to him about his concerns. It turned out he had some apprehensions about the approaching weather conditions but hesitated to voice them directly. Discussing this allowed us to agree on an alternative route, which relieved everyone.” (P5)

Understanding and correctly interpreting non-verbal communication is essential for enhancing team cohesion and operational safety. Training in these skills enables pilots to better manage situational awareness and team dynamics, ensuring effective communication even under stress.

4.6 Theme 6: feedback (positive, negative, constructive, immediate, delayed, etc.)

Feedback is a fundamental component of the communication process, representing the response from the receiver back to the source of the message. Academic literature extensively discusses feedback’s capacity to influence and direct individuals’ or groups’ behaviours, attitudes and performance. Feedback in communication allows individuals to understand the impact of their actions and make necessary adjustments based on this information. This process is critical for both individual and organisational learning and development.

Feedback can be classified from various perspectives:

- *Positive feedback:* Positive feedback is used to praise the recipient’s positive behaviours, achievements or performance. This type of feedback enhances confidence, provides motivation, and encourages the continuation of positive behaviours. Positive feedback helps individuals feel valued and inspired to continue their efforts in the relevant area.
- *Negative feedback:* Negative feedback is given when there is a deficiency or error in the recipient’s performance. Its purpose is to draw the recipient’s attention to these areas and create awareness for improvement. However, negative feedback must be delivered carefully, as its adverse effects can harm the recipient’s motivation and emotional state.
- *Constructive feedback:* Constructive feedback goes beyond positive and negative feedback by providing concrete suggestions and guidance to improve the recipient’s performance. This type of feedback is specific, achievable, and focused on the recipient’s development, making it more valuable and actionable for the recipient.
- *Immediate and delayed feedback:* The timing of feedback is also important. Immediate feedback is given at the moment of the behaviour or shortly after, helping the recipient correct their behaviour quickly. Delayed feedback may require a more comprehensive evaluation and reflection process but can provide deeper learning and understanding in certain situations.

An effective feedback process should respect the recipient, communicate clearly and concisely, and genuinely contribute to the recipient's development. The purpose of feedback is to strengthen communication, encourage learning, and improve individual and organisational performance.

Effective feedback among pilots is vital for flight safety and team coordination. In communication, feedback should be targeted, understandable, actionable, user-friendly, timely, continuous and consistent. Positive feedback reinforces successes, while constructive feedback identifies areas for improvement and offers suggestions. Immediate feedback allows pilots to make quick corrections during flights, while continuous feedback supports long-term skill development. Therefore, pilot training programmes should comprehensively address feedback processes and ensure pilots take active roles in these processes. This approach maximises flight safety by improving individual performance and team dynamics.

In daily flight operations, pilots may face various communicative challenges in giving and receiving feedback. These challenges include the difficulty of providing timely feedback, the lack of clarity and comprehensibility of the message, and decreased sensitivity to feedback under high stress. Increased misunderstandings and decreased team cohesion can directly negatively affect flight safety. Thus, establishing effective feedback mechanisms and ensuring pilots receive appropriate support and training in these processes are critical ways to maximise operational efficiency and safety through deepening mutual understanding. Therefore, it is crucial for pilot training programmes to focus on feedback processes and develop strategies to overcome these challenges.

"In flight operations, sharing messages and providing feedback among flight crews is essential. Sharing information about cabin conditions with the cockpit and sharing all flight-related information between UP (pilot flying) and GP (pilot monitoring) in the cockpit are crucial. To conduct flight operations effectively and safely, communication skills must be used appropriately. Messages must be fully and clearly understood. Unclear messages should be questioned. Problems can arise when messages are complex, multiple messages are conveyed simultaneously, messages are overly long, or communication deviates from conventional forms." (P9)

"Aviation is a unique sector, and the measures taken are more specialized compared to other industries. Fatigue has recently become a critical issue, especially in aviation, and various studies have been conducted on this topic. Fatigue leads to negative communication. Fatigue management controls flight hours. When a pilot is fatigued, a red warning indicates that flying is risky. This risk identification allows fatigue to be eliminated. If a pilot feels unfit to fly, they report their condition to the company, stating that flying is unsuitable due to fatigue. These measures aim to eliminate risks. Efforts to prevent fatigue are conducted before flights. Fatigue also affects communication. Feedback is important here. I ask questions to ensure I fully understand what the other person is expressing. I prefer to listen carefully. During fatigue, especially in conversations with air traffic control, frequency skips can occur." (P7)

4.7 Theme 7: cultural differences

Another communication barrier faced by the global aviation community is the challenge of accurately understanding the nuanced interactions among pilots from diverse cultural backgrounds. For example, while some cultures prefer direct communication styles, others may use more indirect forms of communication. These differences can lead to

misunderstandings among pilots, especially under stress or when quick decisions are needed. Therefore, the clarity and comprehensibility of the language used in aviation are vital for safe and effective communication. Emphasising language training and intercultural communication skills within the aviation industry is essential to ensure effective communication among pilots, thereby enhancing safety. Effective communication in aviation involves not only language proficiency but also cultural awareness and understanding. Pilots and all flight personnel should be trained to communicate across different cultural contexts, and this training should be considered a fundamental part of international flight safety. Such an approach embraces the richness of cultural diversity while helping to prevent misunderstandings and communication errors that could threaten aviation safety.

“We try to overcome these differences by adhering to standards when communicating effectively with team members from different cultural backgrounds.” (P8)

“It is understood that everyone is different in terms of personality and culture, and a comprehensible and social environment in the cockpit is only possible with awareness of these differences, as people have different value judgments. Behavior begets behavior; desired behavior is to be polite, but being overly polite is not desired. However, a warm introduction in the flight briefing room is always a good start. In the end, everyone has potential cultural and personal differences that could disrupt harmony in the cockpit. This is a normal outcome that can occur on every flight, in every company, and almost every setting. As pilots, it is essential for us to perform our duties professionally in all circumstances, use conflict management skills when needed, be open to a respectful and sincere dialogue environment, be understanding and patient, and perform our flight duties safely by setting aside our personal differences.” (P12)

“As is well known, everyone is different, and everyone performs their job in a unique way. This difference, although stemming from the job or environment, is primarily due to each person’s unique character. Many of these individual differences are rooted in personal traits and cultural backgrounds. In multicultural environments like flight operations, especially in large countries with significant local differences like Türkiye, cultural differences among employees are an inevitable reality. Nevertheless, it is mandatory for professional aviators to exhibit standard aviation behavior within their teams, despite cultural differences.” (P4)

“Our company has pilots from many different countries. As a captain, I haven’t faced many difficulties. The respect towards captains in our company is higher. Before becoming a captain, I experienced both positive and negative cultural differences. One challenge was dealing with European captains who ‘didn’t appreciate’ local pilots. I tried to overcome this by focusing more on work and less on personal issues. Misunderstandings can also occur due to differences in gestures and facial expressions. Being clear and understandable can help mitigate cultural differences. Avoiding discussions on cultural, religious, or socio-economic topics during general conversations is one of the tools I use to prevent cultural conflicts.” (P5)

“Twenty years ago, this was a significant problem, but today it hasn’t changed much in terms of significance. The breadth of operations and the impact of the digital world allow us to recognize general aspects of all cultures, even if not in detail. For aviators, different cultures in the cockpit, provided there is no egotistical attitude, can be better than two people from the same culture. This is

because both sides share their life experiences combined with aviation experiences, which is very instructive.” (P13)

“European pilots generally speak directly; they don’t beat around the bush. Working with Asian pilots is a bit different. They value harmony and peace within the group. If they have something to say, they make sure not to be hurtful. They might say, ‘Perhaps we could do it this way, what do you think?’ to introduce the topic gently. For example, while discussing an approach maneuver with a European pilot, you might encounter a direct criticism like, ‘It would have been more sensible to follow this route.’ In contrast, an Asian captain might say, ‘Considering this route might yield better results, what do you think?’ So, the essence is that everyone has a style. My tactic is to listen to everyone and show respect. If misunderstandings arise, I address them immediately to clarify the situation. This way, I strive to understand what everyone means and manage the flight effectively. After all, we are all in the same boat, and the goal is to create an environment where everyone feels comfortable and understood.” (P14)

5 Discussion

The findings from this study, as represented through the thematic analysis diagram, highlight the significant personal factors affecting communication in aviation. The diagram utilises a mind-mapping technique to illustrate how various themes, such as ‘stress and emotional intelligence’, ‘fatigue’, ‘burnout and motivation’ and ‘group dynamics and team cohesion’ are interconnected. These personal factors were frequently mentioned by pilots during the interviews, and their influence on communication effectiveness was emphasised. Pilots acknowledged the importance of managing stress and fatigue, understanding emotional states, and fostering supportive team dynamics as crucial for ensuring clear communication during flights. This diagram demonstrates the complex interplay of these factors, which together shape the overall communication environment in the cockpit.

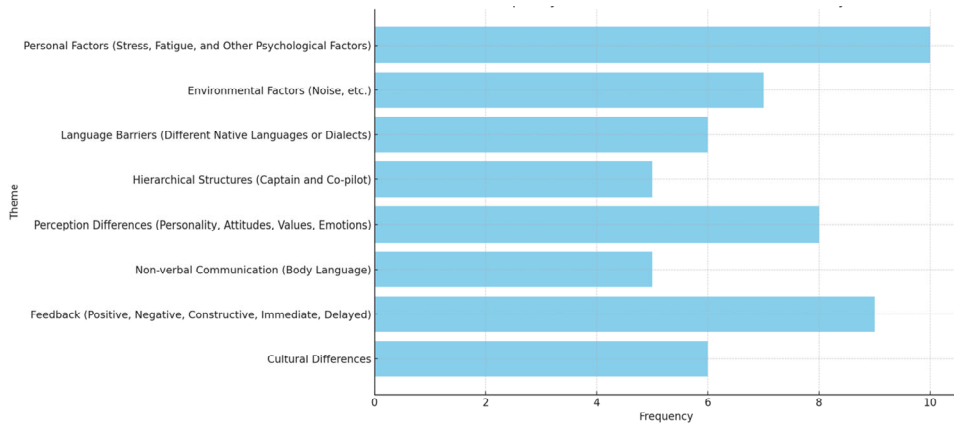
As Alharasees et al. (2023, p.379) highlighted, “non-native English speakers make more mistakes while communicating in comparison to native English speakers, creating confusion and potentially hazardous situations.” This emphasises the critical importance of clear communication, particularly in high-stress or emergency scenarios.

Additionally, the word cloud titled ‘tools and strategies for improving pilot communication’ visually captures the key concepts identified in the research aimed at enhancing communication among pilots. One of the most prominent themes is the importance of CRM training, which was frequently mentioned in relation to teamwork, communication, and decision-making, particularly during high-stress or emergency situations. Pilots consistently emphasised the need for clear communication protocols, such as SOPs and the use of checklists, as fundamental strategies to ensure effective information exchange during flight operations.

Moreover, cultural and language differences can also create significant barriers. According to Alharasees et al. (2023, pp.379–388), “cultural misunderstandings can occur both by native and non-native English speakers, emphasizing the necessity for cultural awareness in aviation.” This further supports the idea that targeted training programmes focusing on cultural and linguistic competence are crucial for effective communication.

To complement these findings, a bar chart titled ‘frequency of themes in pilot communication study’ visually illustrates the most frequently discussed themes. The theme of personal factors (stress, fatigue and other psychological factors) had the highest frequency, with ten mentions, underscoring the significant role these psychological factors play in communication. Pilots frequently reported how stress and fatigue can impede their ability to communicate effectively and maintain situational awareness, which aligns with the broader literature on human factors in aviation.

Figure 3 Frequency of themes in plot communication study (see online version for colours)



Closely following this theme was the frequency of *feedback* (positive, negative, constructive, immediate, delayed), which was mentioned nine times. This reflects the importance pilots place on receiving constructive feedback that helps them adjust and improve their performance in real time. Feedback is crucial for maintaining effective communication, particularly during high-stakes flight operations. Similarly, the theme of *perception differences* (personality, attitudes, values, emotions), with a frequency of 8, further reinforces how individual differences shape communication styles and impact the dynamics within the cockpit.

The analysis also revealed that *environmental factors*, such as cockpit noise, had a frequency of seven mentions. This highlights how physical conditions, such as noise and external distractions, can obstruct clear communication. Additionally, *language barriers* and *cultural differences*, each with six mentions, reflect the complexities of working in diverse, multicultural aviation environments where linguistic proficiency and cultural awareness are essential for effective communication.

While themes such as *hierarchical structures* and *non-verbal communication* were mentioned less frequently, their significance should not be underestimated. These factors play a key role in establishing effective teamwork, ensuring mutual understanding, and promoting safety within the cockpit. Overall, the bar chart provides a comprehensive overview of the critical factors affecting pilot communication, pointing to the need for targeted training programmes and strategic initiatives to address these challenges.

Based on these findings, several recommendations can be made to enhance communication among pilots. First, the implementation of *regular training programmes and simulations* can significantly improve pilots' communication skills, particularly under high-stress conditions. Simulations that replicate real-world flight situations

provide an opportunity for pilots to practice effective communication and decision-making in a controlled environment.

Furthermore, *promoting transparency and open communication* within flight crews is essential for mitigating hierarchical barriers. Creating an environment where all team members, regardless of rank, feel comfortable expressing concerns can improve collaboration and information exchange. Additionally, the introduction of *psychological support and counselling programmes* can help pilots manage personal stress and fatigue, ensuring that these factors do not negatively affect communication during critical phases of flight.

Finally, investing in *technological innovations*, such as noise-cancelling headsets and other advanced communication equipment, can help mitigate the impact of environmental distractions. Combined with enhanced *language and cultural awareness training*, these initiatives can bridge communication gaps, especially in multicultural flight operations, further improving flight safety and operational efficiency.

6 Conclusions

This study has highlighted the critical importance of effective communication among pilots in the aviation sector and provided a comprehensive analysis of the factors that hinder this communication. The research delved deeply into the impacts of effective communication on flight safety and operational efficiency, particularly given the high stress, heavy workload, and chain of unpredictable events inherent to the piloting profession. Through interviews with pilots, the study detailed the communication barriers encountered before and during flights and the strategies to overcome these obstacles.

The findings show that effective communication among cockpit crews plays a crucial role in reducing errors, managing potential threats, improving team performance, and efficiently sharing emergency information. Adherence to sterile cockpit rules has been identified as significantly enhancing the quality and effectiveness of communication during flights, thereby playing a vital role in ensuring flight safety.

By addressing gaps identified in existing literature, this study has allowed for a broader examination of communication barriers among pilots in the aviation sector. Factors such as cultural differences, language barriers, motivational factors, personal characteristics, environmental conditions, non-verbal communication, and hierarchical structures were examined in depth to understand their impact on communication among pilots and how these barriers can be overcome.

The results underscore the need for strategic approaches to ensure effective communication in the aviation sector.

This study not only emphasises the critical role of communication among pilots in flight safety but also offers practical recommendations for enhancing safety and operational efficiency in the aviation industry. The findings provide a fundamental resource for developing more effective communication strategies and policies in the aviation sector, encouraging better communication among pilots.

In conclusion, this study highlights the critical importance of communication in the aviation sector, taking a comprehensive approach to examining communication barriers among pilots and detailing strategies to overcome these barriers. Developing effective communication strategies and policies in the aviation sector will contribute to enhanced

flight safety and operational efficiency. This comprehensive approach aims to provide significant contributions to the aviation industry both theoretically and practically.

Declarations

No potential conflict of interest was reported by the authors.

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