DEVELOPMENT OF AN AIR TRAFFIC CONTROL PHRASEOLOGY HANDBOOK TO IMPROVE AVIATION COMMUNICATION EFFECTIVENESS FOR CADETS AVIATION POLYTECHNIC OF SURABAYA

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ABSTRACT

Aviation safety relies heavily on effective communication between Air Traffic Controllers (ATC) and pilots. Standardized phraseology established by the International Civil Aviation Organization (ICAO) is essential in this context. However, many cadets of the Surabaya Aviation Polytechnic still face difficulties in applying ATC phraseology consistently, which may reduce communication effectiveness. This research aimed to develop an ATC phraseology guidebook as a structured learning tool to enhance cadets' communication skills. The study applied a Research and Development (R&D) approach using the 4D model: Define, Design, Develop, and Disseminate. Due to time and resource limitations, the process was conducted only up to the Develop stage. In the Define stage, needs analysis was carried out through observation and interviews. The Design stage resulted in a draft guidebook based on ICAO Doc 4444 and cadets' needs. The Develop stage included expert validation and limited trials. Findings showed that the guidebook met feasibility standards in content, language, and presentation. Expert reviews confirmed its quality, and trial results indicated improvements in cadets' understanding and use of ATC phraseology. Although dissemination was not completed, the product proved beneficial for supporting aviation communication effectiveness at the Surabaya Aviation Polytechnic.

Keywords: *Air Traffic Control, Phraseology, Aviation Communication, Cadets, Surabaya Aviation Polytechnic, Handbook Development*

1. INTRODUCTION

Politeknik Penerbangan Surabaya (Poltekbang Surabaya), established in 1989 as the Surabaya Aviation Training Center, is a vocational education institution under the Ministry of Transportation of the Republic of Indonesia. Based on the Decree of the Minister of Transportation No. 22 of 1989, its primary mission is to produce competent human resources in the field of air transportation. In 2016, Poltekbang Surabaya was officially designated as a Public Service Agency (Badan Layanan Umum/BLU), enabling more flexible and efficient financial management.

Poltekbang Surabaya offers various diploma programs, including Airport Electrical Engineering, Air Navigation Engineering, Air Traffic Management, Aircraft Engineering, Aviation Management, Airport and Runway Engineering, and Aeronautical Communication. The campus, located on Jalan Jemur Andayani I/73, East Java, is equipped with modern facilities such as classrooms, laboratories, and flight simulators. During their study period, cadets of the Diploma III Air Traffic Control (ATC) program undergo intensive training combining theoretical knowledge with practical simulations and fieldwork. They are also prepared to obtain professional certifications such as Aerodrome Control Tower, Approach Control Procedural, Area Control Procedural, as well as English proficiency certifications including IELP and TOEIC. With a structured curriculum and adequate facilities, the ATC program at Poltekbang Surabaya provides comprehensive preparation for cadets aspiring to become professional air traffic controllers.

The profession of air traffic control demands not only strong technical skills but also high levels of professionalism, precision, and mental resilience (1). Even minor errors in decision-making or communication can have fatal consequences for flight safety. Consequently, cadets are trained to master effective coordination, rapid decision-making, and clear communication aligned with international standards. Since ATC communication involves direct interaction with pilots, English is used as the international language of aviation, and mastery of standard phraseology as established by the International Civil Aviation Organization (ICAO) becomes essential. Therefore, cadets must be equipped with professional communication skills that are not only linguistically fluent but also accurate in terminology and procedures.

Phraseology represents a fundamental competency that every aspiring air traffic controller must acquire, as it ensures safety, efficiency, and fluency in aviation communication (2). According to ICAO DOC 4444, communication must be conducted precisely, swiftly, and in compliance with standardized phraseology. However, observations at Poltekbang Surabaya indicate that many first-year ATC cadets still struggle to understand and apply these standard phrases, both theoretically and in simulated communication practice.

The learning challenges in ATC communication are primarily related to limited contextual learning media, lack of structured instructional materials, and variations in English proficiency levels among cadets, particularly for those from non-native backgrounds such as cadets from Timor Leste. These factors highlight the importance of developing an ATC phraseology handbook tailored to cadets' needs and competencies. Such a handbook is expected to serve as an effective, standardized, and user-friendly learning resource that can significantly improve aviation communication competence.

Another contributing factor is that most cadets have limited prior exposure to aviation practices and insufficient mastery of Aviation English, which forms the foundation for phraseology-based communication. Moreover, the current learning materials tend to be text-based and theoretical, with limited contextual and practical applications. This often results in ineffective communication skills among cadets, particularly in pronunciation, comprehension of instructions, and timely responses.

This phenomenon demonstrates the need for additional learning media that are contextual, practical, and easy to comprehend. One potential solution is the development of a systematically designed phraseology handbook tailored to the initial competence level of first-year cadets. The handbook should not only present communication theory but also include real-life scenarios, interactive dialogue exercises, a glossary of essential phrases, as well as pronunciation and intonation guides. Such an approach is expected to enhance learning interest, accelerate comprehension, and bridge the gap between theory and practice.

By providing a well-structured phraseology handbook, first-year cadets will be better equipped to understand aviation communication structures that comply with international standards, build confidence during practice, and minimize potential errors in advanced training. Therefore, the development of this handbook is considered a strategic step to strengthen fundamental ATC communication competencies from the early stages of education, ultimately contributing to the quality of graduates and ensuring

the overall safety and efficiency of air navigation services.

This study focused on the development of an Air Traffic Control Phraseology Handbook tailored to the learning needs of cadets. Its effectiveness is assessed in terms of improving understanding and verbal communication skills in the aviation context. The purpose of this research is to design and develop the handbook to enhance communication effectiveness among ATC cadets at Poltekbang Surabaya, with the final output reaching the expert validation stage, although dissemination is excluded due to time limitations of the study.

2. LITERATURE REVIEW

2.1 SUPPORTING THEORIES

2.1.1 Phraseology

Phraseology refers to a set of standardized words, expressions, and phrases used in aviation communication to ensure clarity, consistency, and effectiveness in the exchange of information between pilots and air traffic controllers. In aviation, phraseology plays a crucial role as it helps prevent misunderstandings that may pose safety risks. The use of standardized phraseology facilitates communication despite differences in language, accents, or challenging communication conditions.

According to the *ICAO DOC 4444* entitled *Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM)*, phraseology is the official language required in global aviation communication. ICAO establishes standardized phraseology that must be adhered to by all member states to ensure uniformity in international aviation communication (3). This document contains rules and examples of phrases to be applied in various situations, ranging from air traffic control instructions and weather reports to emergency procedures.

The proper use of phraseology in aviation communication is vital for ensuring safety, efficiency, and clarity in the exchange of information between air traffic controllers and pilots. As stipulated in *ICAO DOC 4444*, Chapter 12, standardized phraseology is mandatory in all forms of radio communication to prevent misunderstandings and to ensure that every instruction and piece of information is accurately conveyed and understood. Phraseology thus functions as an international technical language that enables aviation personnel worldwide, regardless of linguistic or national background, to communicate uniformly, concisely, and without ambiguity (4).

Furthermore, Chapter 12 of *ICAO DOC 4444* systematically outlines various operational conditions along with the standardized phraseology to be applied, covering communication during take-off, landing, holding, altitude changes, and emergency situations. The guidelines not only regulate sentence structures but also emphasize the importance of proper sequencing and accurate pronunciation. Adherence to these standards is essential, particularly in critical situations such as adverse weather conditions, high traffic density, or unexpected events. Even the smallest error in applying phraseology may lead to confusion that could compromise the safety of flight operations.

2.1.2 Air Traffic Control Unit

Air Traffic Control (ATC) is a service designed to prevent collisions between aircraft both in the air and on the ground, as well as to maintain the orderly and efficient flow of air traffic. According to the *International Civil Aviation Organization (ICAO) Doc 4444*, Air Traffic Services (ATS) consist of three main components: the Air Traffic Control Service, the Flight Information Service, and the Alerting Service. The primary function of ATC is to ensure flight safety by managing and separating aircraft within controlled airspace and at airports (3).

As outlined in *ICAO Doc 4444*, the Air Traffic Control Service is further divided into three categories: Area Control Service, Approach Control Service, and Aerodrome Control Service. The Area Control Service is provided for aircraft flying along designated air routes, the Approach Control Service is provided for aircraft arriving at or departing from an airport, while the Aerodrome Control Service is responsible for aircraft operations in the vicinity of an airport, including take-off and landing. Each type of service carries specific responsibilities to ensure the safety and smooth flow of air traffic (4).

Beyond its separation function, ATC also plays a crucial role in delivering essential information to pilots, such as weather conditions, traffic activity, and airport status. This function is performed through the Flight Information Service (FIS), which is an integral part of Air Traffic Services. Therefore, ATC not only serves as a traffic management system but also as a critical source of information that supports pilots in maintaining situational awareness throughout the flight (5).

2.1.3 Aerodrome Control Tower Unit

The Aerodrome Control Tower is an air traffic control unit responsible for managing aircraft and vehicle movements within the airport area, including runways, taxiways, and aprons. It provides control services to ensure the safety of take-off, landing, and ground operations. In accordance with *ICAO DOC 4444*, the Aerodrome Control Tower employs visual observation, radio communication, and surface

movement radar systems to monitor aircraft and vehicle movements in real time (4).

Its role is crucial in managing airport traffic by granting clearance for take-off and landing, as well as regulating ground movements. This includes authorizing runway entry, coordinating runway crossings, and managing push-back and start-up operations for departing aircraft. The decisions made by the Aerodrome Control Tower are highly significant, as the take-off and landing phases are the most critical and high-risk stages of a flight.

In addition, the Aerodrome Control Tower is responsible for handling emergency situations that may occur at the airport, including evacuation, firefighting, and coordination with search and rescue (SAR) units when required. Therefore, the Aerodrome Control Tower serves as a vital component in ensuring the safety of airport operations and the smooth movement of aircraft and vehicles within the aerodrome area.

2.1.4 Approach Control Unit

Approach Control is an air traffic control unit responsible for managing aircraft during the approach phase toward an airport as well as the departure phase from the airport. This unit typically oversees the terminal maneuvering area (TMA) surrounding an airport, with a monitoring radius of up to 50 nautical miles, depending on the complexity and traffic volume of the airspace. The primary role of Approach Control is to ensure that aircraft follow the correct flight path when entering or leaving the TMA while maintaining safe separation between aircraft.

In carrying out its functions, Approach Control utilizes approach radar or terminal radar to monitor aircraft positions in real time, providing guidance on heading, altitude, and speed. This is in accordance with *ICAO DOC 4444*, which emphasizes the importance of safe and efficient traffic management during the critical phases of approach and departure. Approach Control is also responsible for managing landing sequences, missed approach procedures, and aircraft sequencing to ensure the smooth operation of airport traffic (4).

Furthermore, Approach Control must coordinate closely with the Area Control Center and the Aerodrome Control Tower to ensure seamless transitions between the en-route and terminal phases of flight. This includes the transfer of control for aircraft entering or exiting the approach area as well as the management of holding patterns when necessary. Thus, Approach Control plays a vital role in maintaining both safety and operational efficiency in the vicinity of airports.

2.1.5 Area Control Center

The Area Control Center (ACC) is an air traffic control unit responsible for managing aircraft during the en-route phase of flight, which occurs after take-off and before the approach for landing. The ACC ensures that each aircraft remains on a safe trajectory by maintaining proper separation standards and managing the flow of traffic to prevent congestion along major air routes. In accordance with *ICAO DOC 4444*, the Area Control Center employs technologies such as surveillance radar, flight plan systems, and radio communications to monitor aircraft movements in real time.

Beyond maintaining safe separation, the ACC also provides pilots with essential information on weather conditions, navigation, and alerting services when necessary. This role is crucial for ensuring both the efficiency and safety of flight operations, particularly within airspace sectors that often experience high traffic density. Typically, an ACC operates from a centralized control facility equipped with advanced systems, including long-range radar, data communication networks, and simulation devices for air traffic controller training (4).

Close coordination between the Area Control Center and other control units, such as Approach Control and Aerodrome Control Towers, is essential to ensure smooth transitions between different phases of flight. This includes the transfer of responsibility for aircraft as they enter or exit controlled sectors. Consequently, the ACC plays a vital role in maintaining the safety and efficiency of air traffic management at both national and international levels.

2.1.6 Effectivity of Phraseology

The effective use of phraseology in aviation communication is essential for ensuring safety and efficiency in air traffic management. Standardized phraseology, as outlined in *ICAO DOC 4444 Air Traffic Management*, minimizes ambiguity, misinterpretation, and miscommunication between air traffic controllers and pilots. Consistent application enables fast, accurate, and efficient exchanges, which are particularly critical in emergency situations or during periods of high traffic density (4). Beyond enhancing operational safety, uniform phraseology also facilitates international interoperability and supports training by providing a clear framework for new personnel to adapt to real operational environments.

To assess the effectiveness of radiotelephony in accordance with *ICAO DOC 4444* (Chapter 12 – Phraseologies), several criteria are emphasized: clarity (accuracy and absence of ambiguity), conciseness (delivery of only essential information),

correctness/compliance (adherence to standard phraseology), responsiveness (timely replies to ATC instructions), and the absence of miscommunication (minimized incidents of misunderstanding or incorrect readback). These criteria ensure that phraseology not only strengthens flight safety but also improves efficiency, reduces cognitive workload for both controllers and pilots, and enhances professionalism in aviation communication (4).

2.1.7 Communication

Communication in aviation is a critical factor that directly affects operational safety and efficiency. It involves the exchange of information between air traffic controllers, pilots, and other stakeholders such as airport personnel. Effective communication requires clear, unambiguous language and mutual understanding among all parties involved, as even minor errors may lead to serious incidents. To minimize such risks, standardized phraseology established by the International Civil Aviation Organization (ICAO) is applied, ensuring that every message is conveyed accurately and consistently across international boundaries. Proper training in phraseology is therefore essential for both air traffic controllers and pilots to prevent miscommunication that could compromise flight safety (3).

In addition to standardized language, advances in communication technology also play a vital role in enhancing efficiency and reliability in aviation communication. Tools such as radar, satellite-based systems, and automated data exchange enable faster and more precise information delivery. Research by Gómez-Galán et al. highlights that modern systems like data link communication improve information management while reducing the likelihood of miscommunication. These technological developments, combined with standardized phraseology, contribute to more effective communication and ultimately strengthen aviation safety (6).

2.2 Relevant Previous Studies

Several previous studies have examined various aspects of air traffic control communication, ranging from operational strategies and workload factors to competence development and training approaches. These studies provide valuable insights into the importance of effective communication, standardized phraseology, and skill enhancement in ensuring flight safety. The following review highlights five relevant studies that serve as references and comparisons for the present research.

Ni Luh Candra Ulandari, Dhiani Dyahjatmayanti, and Yune Andryani Pinem (2022) conducted a study entitled *Analysis of Air Traffic Control Communication Strategies at AirNav Indonesia Denpasar Branch*. The study identified communication strategies used by air traffic controllers, including routine transmission checks, the use of Aviation English, and the management of psychological factors. Challenges encountered included material errors, environmental barriers, and controller conditions. Both this study and the present research emphasize the importance of Aviation English and communication effectiveness in ensuring flight safety. However, while their study focused on operational communication strategies in an ATC environment, the present research is oriented toward developing a phraseology handbook for cadets.

R. Iwan Ardiansyah in his research titled *Analysis of Communication Effectiveness between Controllers and Flights in Jakarta Approach Unit Terminal West Sector* revealed that message structure has a strong correlation with communication effectiveness. Factors such as communication facility conditions and aircraft movement density also influence effectiveness. Both his study and the present research highlight the importance of message structure and standardized phraseology in ATC communication. The key difference lies in the approach: his study analyzed operational communication using recorded data, while the present research focuses on the development of educational materials for cadets (7).

Hendiyanto and Isnawijayani in their article *Analysis of Air Traffic Controller Communication and Workload in Maintaining Flight Safety at AirNav Indonesia Palembang Branch*, emphasized that effective communication between controllers and pilots is critical for maintaining flight safety. They found that time pressure, fatigue, and stress significantly affect ATC communication. The similarity with the current research lies in highlighting the importance of effective communication for safety (8). The distinction, however, is that their study concentrated on workload and psychological factors of ATC in operational settings, while the current study develops a phraseology handbook for instructional purposes.

Imam Sonhaji, Lina Rosmayanti, Emilia Rahajeng Larasati, Gilang Trio Putra, and Andini Ayu Dyah F (2023) presented a study entitled *Enhancing the Competitiveness of Air Traffic Control Graduates at the Indonesian Aviation Polytechnic (PPI) Curug through Human Factor Training*. Their research concluded that human factor training enhances graduates' knowledge, skills, and attitudes in managing human-related issues as a foundation for

flight safety. Both studies aim to improve cadets' competencies in aspects supporting aviation safety (9). The difference lies in the focus: their study concentrated on human factor training to increase graduate competitiveness, while the present research develops a phraseology handbook to strengthen communication competence.

Sa Shindy Esa Putri Irianto, in her research *Development of Air Traffic Controller Competence and Implementation of Duties, Functions, and Responsibilities of ATC Service Units at AirNav Sentani Branch*, examined competence development through training and task allocation based on ratings, as well as the implementation of ATC duties and responsibilities. Similar to the present research, her study emphasized the importance of competence development in improving ATC service effectiveness and safety (10). However, while her research addressed competence development within the professional work environment, the present research focuses on developing learning materials specifically a phraseology handbook for cadets in training.

3. METHODOLOGY

3.1 Research Design

This study employed a Research and Development (R&D) approach based on Sugiyono's model, which includes stages such as identifying problems, collecting information, product design, validation, revision, limited trials, and final refinement (11). The model was chosen because the research aims to develop a learning product, namely an *Air Traffic Control Phraseology Handbook*, to help cadets improve effective communication in aviation according to international standards. The subjects were Diploma III Air Traffic Management cadets at Politeknik Penerbangan Surabaya, while the object of research was the development of the handbook. The content includes ICAO-standard phraseology with translations, explanations, usage contexts, and practice exercises to support cadets in understanding and applying the phrases in real situations.

3.2 Handbook Design

The design of the handbook involved a team consisting of aviation communication experts, Air Traffic Control instructors, and practitioners experienced in training cadets at Politeknik Penerbangan Surabaya, as well as lecturers and researchers specializing in phraseology and educational material development. The process began with identifying cadets' difficulties in applying accurate and effective ATC phraseology, followed by analyzing existing materials and gathering user needs to ensure comprehensive coverage of essential aspects. Emphasis during the design stage was placed on clarity and completeness of instructions to support cadets' understanding and realistic application of phraseology in communication.

3.3 Testing Techniques

The developed handbook was submitted to experts in Air Traffic Control, flight instructors, and educational material developers for validation. This stage aimed to gather feedback on the accuracy, completeness, and alignment of the handbook with international phraseology standards, as well as to assess the clarity of instructions and their relevance to cadet training at Politeknik Penerbangan Surabaya. Following expert review, a product trial was conducted through ATC simulation exercises involving cadets and instructors to evaluate the handbook's effectiveness in supporting accurate communication and compliance with established procedures. The next stage involved testing with cadets, where their communication skills were measured after using the handbook in simulated ATC scenarios. Additionally, questionnaires were distributed to assess cadets' comfort, comprehension, and perceived completeness of the handbook content.

3.4 Data Analysis Techniques

The data analysis in this study was conducted to describe and interpret information obtained from validators regarding cadets' needs, understanding, and communication challenges in the use of phraseology. The analysis followed the stages proposed by Sugiyono, namely data reduction and conclusion drawing. Data reduction involved sorting, selecting, and focusing on information considered important and relevant. The reduced data were then presented in narrative or tabular form to facilitate interpretation, followed by drawing conclusions to ensure the accuracy of findings and provide a deeper understanding of the research context (11).

3.5 Research Location and Time

This research was conducted at Politeknik Penerbangan Surabaya, located at Jl. Jemur Andayani I No. 73, Siwalankerto, Wonocolo District, Surabaya City, East Java 60236. The location was chosen as the site for observation and data collection in accordance with the applied methodology. The research activities included observation, literature review, title submission, proposal preparation, proposal guidance, and proposal defense, which were carried out within the research timeline. Data collection was conducted over a four-month period, from January to April 2025.

4. RESULTS AND DISCUSSION

4.1 Research Results

4.1.1 Define

Cadets at Politeknik Penerbangan Surabaya still face challenges in mastering Air Traffic Control (ATC) phraseology, primarily due to the lack of suitable learning materials that are accessible and aligned with their level of understanding. Existing resources are often too technical, foreign-language based, and not contextualized for beginner cadets, leading to difficulties in grasping the meaning, structure, and application of phrases in both theory and practice. To address this gap, this study aims to develop a communicative and contextual ATC phraseology handbook based on ICAO standards, designed to be practical and easy to understand. The handbook includes translations, explanations, and real-world practice exercises to strengthen cadets' comprehension and application of phraseology in training simulations (5). Beyond improving understanding, the handbook is intended to build professional communication skills that meet ICAO standards, emphasizing the importance of clear, concise, and standardized phraseology to ensure aviation safety.

4.1.2 Design

In the design stage, the initial product was developed in the form of an Air Traffic Control (ATC) phraseology handbook aimed at improving the communication skills of cadets at Politeknik Penerbangan Surabaya. The design was based on ICAO Doc 4444 Chapter 12 and presented in tables that include phraseology, usage context, meaning, and Indonesian equivalents to support non-native English learners (5). This practical and systematic approach enables cadets not only to memorize phrases but also to understand when and how to use them in real aviation communication.

Figure 1. The handbook's cover design

The handbook's cover design highlights key visual elements such as a commercial aircraft, an ATC tower, and a cloudy sky to symbolize pilot–controller communication, supported by a professional color palette of sky blue, orange, and white. The institutional logo and clear sans-serif typography reinforce its academic authority and readability, creating a balanced and informative visual identity.

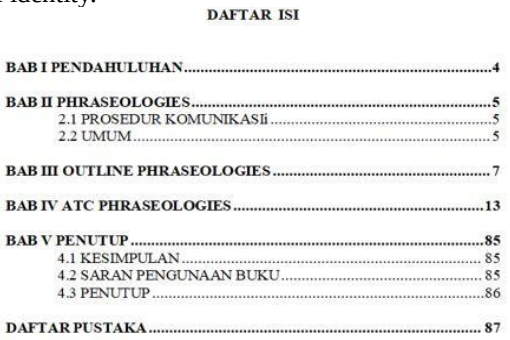


Figure 2. Table of Content

The table of contents was designed systematically, presenting chapters I–V and the bibliography with clear numbering, titles, and page references for easy navigation.

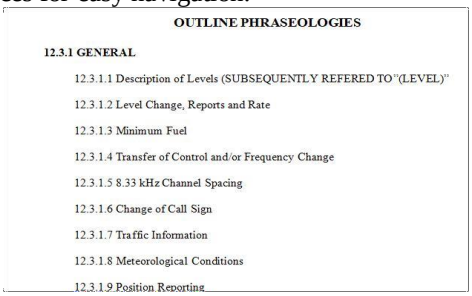
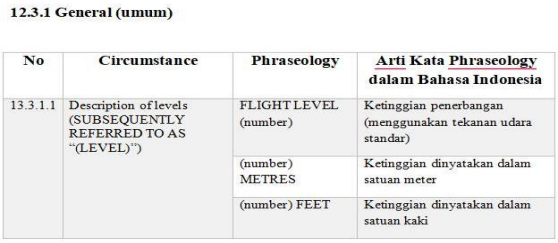


Figure 3. The Outline

The outline section serves as the main framework of phraseology material, organized by types of air traffic services. It follows a logical sequence from general phrases to area control, approach control, aerodrome control, and advanced communication systems such as CPDLC and ADS-B. This outline acts as the blueprint for developing the content in Chapter IV.



12.3.1 General (umum)

No	Circumstance	Phraseology	Arti Kata Phraseology dalam Bahasa Indonesia
13.3.1.1	Description of levels (SUBSEQUENTLY REFERRED TO AS "(LEVEL)")	FLIGHT LEVEL (number)	Ketinggian penerbangan (menggunakan tekanan udara standar)
		(number) METRES	Ketinggian dinyatakan dalam satuan meter
		(number) FEET	Ketinggian dinyatakan dalam satuan kaki

Figure 4. Table Format

This section serves as the main framework for phraseology material based on types of air traffic services. The outline is arranged in a logical sequence, starting from general phrases to area control, approach control, aerodrome control, and advanced systems such as CPDLC and ADS-B, forming the blueprint for Chapter IV. The guidebook is presented in a tabular format aligned with ICAO Doc 4444 Chapter 12, systematically organized by service categories such as General, Area Control, Approach Control, and Aerodrome Phraseologies. Each table consists of three key columns: circumstance (situational context), phraseology (standard phrases used by Air Traffic Control and pilots), and meaning (Indonesian translation of the phraseology) (5).

4.1.3 Develop

In the Develop stage of the 4D model, the guidebook was compiled in full, including a foreword, user instructions, ICAO Doc 4444–based phraseology materials, sample dialogues, exercises, and a glossary. The draft was then validated by experts in Air Traffic Control communication and teaching to assess its feasibility and relevance. Based on expert feedback, revisions were made before conducting limited trials with cadets at the Aviation Polytechnic of Surabaya. The trial aimed to evaluate clarity, usability, and effectiveness in improving cadets' communication skills. Further refinements were applied to ensure the guidebook is accurate, practical, and ready for use as a learning medium.

4.1.4 Validation

Table 1. Language Validation Results

No	Aspek Penilaian	Indikator Penilaian	Skor Nilai			
			1	2	3	4
1	Aspek Penggunaan Bahasa	Keakuratan struktur kalimat				✓
		Keefektifan kalimat				✓
		Kejelasan bahasa dalam materi				✓
		Kejelasan kalimat				✓
		Kemenarikan gaya bahasa				✓
2	Aspek Ketepatan Bahasa	Menggunakan kaidah Bahasa Indonesia				✓
		Kejelasan huruf				✓
		Simbol yang digunakan				✓
		Kejelasan kata perintah/petunjuk				✓
3	Aspek Kesesuaian Perkembangan Peserta Didik	Bahasa yang digunakan sederhana, lugas, mudah dipahami				✓
		Bahasa yang digunakan disesuaikan dengan perkembangan bahasa anak				✓
		Bahasa dapat merangsang imajinasi				✓
		Bahasa mudah dipahami peserta didik				✓
Total Skor			52			
Persentase Skor			100			
Kriteria Validitas			Sangat Layak			

Language validation ensures that grammar, sentence structure, and terminology in the *Air Traffic Control Phraseology* guide are accurate, clear, and easy to understand. This process, conducted by English language experts familiar with aviation communication, guarantees readability and effective comprehension for cadets.

Table 2. Content Expert Validation Results

No	Aspek Penilaian	Indikator Penilaian	Skor Penilaian			
			1	2	3	4
1	Kesesuaian Materi	Kelengkapan materi				✓
		Keluasan materi				✓
		Kedalaman materi				✓
		Kesesuaian arti kata phraseology dalam bahasa Indonesia				✓
		Kesesuaian materi Doc				✓

		4444 Chapter 12				
2	Keakuratan Materi	Keakuratan konsep				✓
		Keakuratan istilah				✓
Total Skor			28			
Persentase Skor			100%			
Kriteria validita			Sangat Layak			

Content validation was carried out by instructors or academics with expertise in ICAO Doc 4444 phraseology to ensure completeness, accuracy, and alignment with cadets' competency needs. This process guarantees that the guide effectively supports instructional goals and can be used reliably in teaching and learning activities.

Table 3. Design Validation Results

Aspect Evaluated	
1. Content Feasibility 2. Book Cover Design 3. Book Content Design 4. Book Content Illustration	
Total Score	144
Percentage Score	100%
Validity Criteria	Highly Feasible

Design validation was conducted by educational media experts to assess the book's visuals, layout, and presentation structure. This ensures that consistent design, typography, and color use create an engaging format that supports cadets' understanding and enhances learning effectiveness.

4.2 Discussion

This research produced an Air Traffic Control Phraseology Guidebook designed as a learning support medium for cadets at the Aviation Polytechnic of Surabaya. The development process applied the 4D Research and Development (R&D) model but was limited to the product validation stage due to time constraints, without proceeding to field trials or dissemination. The stages included *Define* to identify learning needs and problems, *Design* to develop content based on ICAO Doc 4444 Chapter 12, and *Develop* to compile and refine the product based on expert feedback. Validation involved three experts content, language, and design to ensure accuracy, clarity, and quality (4). The results showed a 100% "Highly Feasible" score in both language and content validation, confirming linguistic clarity, terminological accuracy, and alignment with ICAO standards, while design validation verified that visuals, layout, and typography met proper learning media criteria.

5. CONCLUSION

This study resulted in the development of an Air Traffic Control Phraseology Guidebook aimed at enhancing aviation communication skills for cadets at the Aviation Polytechnic of Surabaya. The product was developed using the 4D Research and Development (R&D) model, but implementation was limited to expert validation due to time constraints. The book's content was designed based on ICAO Doc 4444 Chapter 12, enriched with Indonesian translations, phrase meanings, and contextual usage to ensure accessibility for cadets, including non-native English speakers. Validation results confirmed the guidebook's high feasibility in terms of language, content, and design, with both language and content experts awarding a 100% "Highly Feasible" score, while design validation verified effective layout, typography, and visual presentation. Although no field testing was conducted, the validation data demonstrated strong potential for the book to support cadets in understanding and applying ICAO-standard phraseology. Thus, the guidebook can serve as both a supplementary reference and self-learning material in aviation communication training, applicable not only at the Aviation Polytechnic of Surabaya but also in other aviation education institutions.

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REFERENCES

[1]. Kabashkin I, Misnevs B, Zervina O. Artificial Intelligence in Aviation: New Professionals for New Technologies. Appl

Sci. 2023;13(21).

[2]. Yan Y, Wang K, Qu X. Urban air mobility (UAM) and ground transportation integration: A survey. Front Eng Manag. 2024;11(4):734–58.

[3]. ICAO ICAO. Doc 9859, Safety Management Manual (SMM) [Internet]. Doc 9859 AN/474. 2013. 251 p. Available from: http://www.icao.int/fsix/_Library/SMM-9859_1ed_en.pdf%5Cnfile:///C:/Users/Danilo/Downloads/Safety_management_and_risk_modelling_in_aviation.pdf%5Cnhttp://www.easa.eu.int/essi/documents/Methodology.pdf

[4]. Schubert F. Air Traffic Management. Elgar Concise Encycl Aviat Law. 2023;(June):43–5.

[5]. Procedures GO. Section 8 Communications Procedures and Standard Phraseology General Operating Procedures. 2009;(July):1–48.

[6]. Gómez-Galán J, López-Meneses E, Cobos-Sanchiz D. Diachronic research on the time of internet use for academic tasks by Spanish-speaking university students in the pre-COVID era. Discov Educ [Internet]. 2024;3(1). Available from: https://doi.org/10.1007/s44217-024-00116-8

[7]. Oe J, Vii V. Ardiansyah 238 – 251 Jurnal OE, Volume VII, No. 3, November 2015. 2015;VII(3):238–51.

[8]. Hendiyanto, Isnawijayani. Analisis Komunikasi Beban Kerja Air Traffic Controller (ATC) dalam Menjaga Keselamatan Lalu Lintas Penerbangan di Airnav Indonesia Cabang Palembang. J Indones Manaj Inform dan Komun. 2024;5(1):244–54.

[9]. Sonhaji I, Rosmayanti L, Larasati ER, Putra GT, Dyah F AA. Peningkatan Daya Saing Lulusan Air Traffic Control (ATC) Politeknik Penerbangan Indonesia (PPI) Curug Melalui Pelatihan Human Factor. Surya Abdimas. 2023;7(3):383–90.

[10]. Esa S, Irianto P, Tinggi S, Kedirgantaraan T. PENGEMBANGAN KOMPETENSI AIR TRAFFIC CONTROLLER DAN IMPLEMENTASI TUGAS , FUNGSI SERTA TANGGUNG JAWAB KERJA UNIT PELAYANAN AIR TRAFFIC CONTROL SERVICES DI KANTOR AIRNAV CABANG Pendahuluan Air Traffic Controller (ATC) merupakan Pemandu Lalu Lintas Penerbangan bekerja dan beroperasi sebagai penyedia Making Separation . Air Traffic Controller (ATC) mempunyai berdasarkan unit pelayanan yang diberikan . Air Traffic Control Service atau Pelayanan Pemanduan Lalu Lintas Penerbangan terbagi menjadi tiga unit pelayanan , antara lain yaitu Area. 2020;1(1):64–75.

[11]. Sugiyono. Metode Penulisan Kualitatif. Metod Penelit Kualitatif. 2022;1–274.