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Effect of ATC Understanding of Cockpit Procedures on Performance in Jakarta ATSC ACC Unit

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Abstract

Aviation safety is a fundamental priority in modern air transportation systems, where effective communication and coordination between pilots and Air Traffic Controllers (ATCs) are essential. This study aims to examine the effect of ATC understanding of cockpit procedures through Flight Simulator media on ATC performance at the Area Control Centre (ACC) Unit of Jakarta Air Traffic Services Center (JATSC), operated by Perum LPPNPI (AirNav Indonesia). The research employed a quantitative approach using a survey method. Data were collected through structured questionnaires distributed to 69 active ATCs working at the ACC unit. The research instruments were developed based on indicators of cockpit procedure understanding and ATC performance and were tested for validity and reliability. Data analysis was conducted using descriptive statistics, prerequisite testing, and Kendall's Tau correlation analysis to examine the relationship between variables. The results show that both the level of ATC understanding of cockpit procedures and ATC performance are generally high. Furthermore, the analysis indicates a positive and significant relationship between understanding cockpit procedures and ATC performance. In conclusion, enhanced comprehension of cockpit procedures through simulator-based training contributes to improved ATC performance and supports operational effectiveness and aviation safety within the Jakarta Flight Information Region

Keywords: Air Traffic Controller, Cockpit Procedures, Flight Simulator, ATC Performance, Aviation Safety

INTRODUCTION

Aviation safety is a fundamental and non-negotiable priority in modern air transportation systems. This principle is not only ethically imperative but also strictly regulated through national and international aviation frameworks. In Indonesia, aviation safety is legally mandated under Law Number 1 of 2009 on Aviation, which explicitly emphasizes that safety is the highest priority in all aviation operations. This national commitment aligns with the global safety standards established by the International Civil Aviation Organization (ICAO), particularly through the implementation of the State Safety Program (SSP). The SSP requires aviation service providers, including Perum LPPNPI (AirNav Indonesia), to implement a comprehensive Safety Management System (SMS) that systematically manages operational risks through organizational structures, policies, and standardized procedures. Within this safety framework, effective interaction and communication between pilots and Air Traffic Controllers (ATCs) constitute a critical element in ensuring safe, orderly, and efficient air traffic operations.

According to ICAO Annex 11 on Air Traffic Services, the primary objectives of air traffic services include preventing collisions between aircraft, maintaining safe distances from obstacles, expediting and maintaining an orderly flow of air traffic, providing information essential to flight safety, and coordinating search and rescue operations when necessary (ICAO, 2018). Despite continuous advancements in aviation technology, human factors remain the dominant contributors to aviation incidents and accidents. Ineffective communication, procedural misunderstandings, and incorrect interpretation of instructions can significantly reduce response time and escalate operational risks. Several aviation incidents have demonstrated that communication breakdowns between pilots and ATCs, often influenced by non-standard

phraseology or incomplete procedural understanding, can lead to near-miss situations or severe safety consequences.

In this context, ATC understanding of cockpit procedures becomes increasingly important. Cockpit procedures refer to the standardized operational steps executed by pilots during all phases of flight, including normal, abnormal, and emergency conditions. These procedures encompass checklist execution, communication protocols, readback and hearback processes, and coordination of flight maneuvers. Standardized communication procedures, including the use of ICAO phraseology and phonetic numbers, are essential to minimize ambiguity and misinterpretation during pilot ATC interactions (Dika Tutiaditama & Muchammad Furqon Muchaddats, 2024). Furthermore, aviation regulations emphasize the legal authority and responsibility of the Pilot in Command as the final authority for aircraft operation and safety, reinforcing the importance of mutual procedural understanding between pilots and ATCs (Ministry of Transportation, Directorate General of Civil Aviation, 2009).

This study focuses specifically on the Area Control Centre (ACC) Unit of Jakarta Air Traffic Services Center (JATSC), which operates within the highly congested Jakarta Flight Information Region (FIR). The Jakarta FIR is one of the busiest and most complex airspaces in Southeast Asia, characterized by high traffic density, dynamic weather conditions, and frequent operational contingencies. ATCs in the ACC Jakarta Unit are responsible for managing en-route flights under demanding cognitive and operational pressures. High workload levels may affect decision-making quality and increase the risk of communication errors, particularly when ATCs lack sufficient understanding of pilot cockpit procedures. Several aviation investigation reports in Indonesia, including cases documented by the National Transportation Safety Committee (KNKT), highlight the critical role of ATC pilot communication during the final stages of flight operations, underscoring the safety implications of procedural misunderstanding.

Previous empirical research has demonstrated a significant positive relationship between cockpit procedure understanding and ATC situational awareness, with a coefficient of determination exceeding 60% in less complex operational environments (Dika Tutiaditama & Muchammad Furqon Muchaddats, 2024). However, similar studies focusing on the highly complex operational context of the ACC Jakarta Unit remain limited. Therefore, an empirical investigation is necessary to examine whether ATC understanding of cockpit procedures, particularly when enhanced through Flight Simulator-based training, significantly influences ATC performance in this challenging operational environment.

Based on the background described above, the research problem is formulated as follows: *Does ATC understanding of cockpit procedures have a significant effect on ATC performance at the ACC Unit of Jakarta Air Traffic Services Center?* Accordingly, the objective of this study is to empirically analyze the effect of ATC understanding of cockpit procedures on ATC performance at the ACC Jakarta Unit. The findings are expected to contribute both theoretically to aviation human factors research and practically to the development of training strategies that enhance communication effectiveness, operational performance, and aviation safety within the Jakarta FIR

RESEARCH METHODS

This study employed a quantitative research approach using a survey-based correlational design to examine the effect of Air Traffic Controller (ATC) understanding of cockpit procedures on ATC performance at the Area Control Centre (ACC) Unit of Jakarta Air Traffic Services Center (JATSC), operated by Perum LPPNPI (AirNav Indonesia). The quantitative approach was selected to allow objective measurement of variables and statistical examination of the

relationship between procedural understanding and performance outcomes within an operational aviation environment (Sugiyono, 2020).

Research Setting and Participants

The research was conducted at the ACC Unit of JATSC, which provides en-route air traffic control services within the Jakarta Flight Information Region (FIR), one of the busiest and most complex airspaces in Southeast Asia. The research population consisted of all active ATCs who had participated in the Flight Deck Home Simulator Course, a training program designed to enhance ATC understanding of pilot cockpit procedures. Given the specific and limited population size, a total sampling technique was applied, resulting in 69 ATCs as research respondents. This approach ensured that all eligible participants were included and that the data accurately reflected the characteristics of the population under study.

Research Variables

The independent variable in this study was ATC understanding of cockpit procedures, defined as the level of ATC knowledge and comprehension regarding pilot operational procedures during normal, abnormal, and emergency phases of flight. This variable included understanding of checklist execution, cockpit workflow, communication procedures, and pilot decision-making processes.

The dependent variable was ATC performance, defined as the effectiveness of ATC duties in managing air traffic safely and efficiently, including communication clarity, response accuracy, situational awareness, coordination, and adherence to operational procedures.

Research Instruments

Data were collected using a structured questionnaire developed based on relevant aviation regulations and literature. The questionnaire items were derived from ICAO Annex 11 (Air Traffic Services), Annex 10 (Aeronautical Telecommunications), and Doc 4444 (PANS-ATM), as well as national aviation regulations issued by the Ministry of Transportation (ICAO, 2016; ICAO, 2018; Ministry of Transportation, 2009). Responses were measured using a five-point Likert scale, ranging from strongly disagree to strongly agree, to capture respondents' perceptions and self-assessments.

Data Collection Procedure

Prior to distribution, the questionnaire was reviewed to ensure clarity and relevance to operational conditions. Data collection was conducted after the completion of the Flight Deck Home Simulator Course to ensure that respondents had sufficient exposure to cockpit procedure training. Participation was voluntary, and respondents were informed about the purpose of the study. The completed questionnaires were checked for completeness before further analysis.

Data Analysis Techniques

Data analysis was conducted using SPSS software. Initial analysis involved descriptive statistics to summarize respondent characteristics and variable tendencies. Instrument testing included validity and reliability testing to ensure measurement accuracy and consistency. A normality test was conducted as a prerequisite analysis. Due to the ordinal nature of the data, Kendall's Tau correlation analysis was employed to examine the strength and direction of the relationship between ATC understanding of cockpit procedures and ATC performance. This method is commonly used in social and behavioral research involving ranked or ordinal data (Sugiyono, 2020).

RESULT AND DISCUSSION

This section presents and discusses the research findings concerning the effect of Air Traffic Controller (ATC) understanding of cockpit procedures on ATC performance at the Area Control Centre (ACC) Unit of Jakarta Air Traffic Services Center (JATSC). The results are based

on data collected from 69 active ATCs who participated in the Flight Deck Home Simulator Course. The findings are interpreted by integrating descriptive analysis, prerequisite testing, and correlational results to provide a comprehensive understanding of the relationship between procedural understanding and operational performance.

Respondent Profile and Descriptive Overview

The respondents consisted of professional ATCs assigned to the ACC Unit of JATSC, operating within the Jakarta Flight Information Region (FIR), a highly complex and dense airspace. Most respondents demonstrated substantial operational exposure, reflecting a professional environment characterized by high traffic volume and significant cognitive demands. The descriptive analysis indicates that both research variables ATC understanding of cockpit procedures and ATC performance were perceived at a high level by respondents. This reflects the effectiveness of simulator-based training in enhancing procedural awareness and operational readiness, particularly in environments requiring precise coordination and rapid decision-making (ICAO, 2018).

Table 1. Descriptive statistics of research variables

Variable	Mean score category	Interpretation
ATC understanding of cockpit procedures	High	Strong procedural awareness
ATC performance	High	Effective operational performance

Table 1 summarizes the overall tendency of respondents' perceptions regarding the research variables, indicating consistently high assessments for both procedural understanding and ATC performance.

The high level of cockpit procedure understanding suggests that exposure to Flight Simulator–based training provides ATCs with an enhanced perspective of pilot workload, cockpit workflows, and procedural constraints. This finding supports previous studies highlighting the role of experiential learning tools in strengthening operational empathy and situational awareness among ATCs (Dika Tutiaditama & Muchammad Furqon Muchaddats, 2024).

Instrument Quality and Data Distribution

Instrument testing confirmed that all questionnaire items met validity and reliability criteria, indicating that the instruments consistently measured the intended constructs. The reliability assessment demonstrated strong internal consistency, supporting the credibility of the collected data. Normality testing further indicated that the data distribution met analytical requirements, allowing for subsequent relational analysis. These findings confirm that the dataset provides a reliable basis for examining the interaction between cockpit procedure understanding and ATC performance (Sugiyono, 2020).

Table 2. Instrument reliability summary

Variable	Reliability level	Interpretation
Cockpit procedure understanding	Reliable	Consistent measurement
ATC performance	Reliable	Consistent measurement

Table 2 presents the reliability assessment of research instruments, confirming acceptable internal consistency across variables.

Relationship Between Cockpit Procedure Understanding and ATC Performance

The correlational analysis revealed a positive and meaningful association between ATC understanding of cockpit procedures and ATC performance. This relationship indicates that

higher procedural understanding is aligned with improved communication clarity, more accurate response timing, and more efficient traffic flow management. Rather than focusing on statistical terminology, these findings suggest that procedural familiarity enables ATCs to issue clearer instructions and anticipate pilot responses more effectively, thereby reducing the likelihood of miscommunication in high-density airspace.

This result is consistent with ICAO's emphasis on shared situational awareness and standardized procedures as core elements of aviation safety management (ICAO, 2016; ICAO, 2018). In the operational context of Jakarta FIR, where workload and complexity are inherently high, enhanced understanding of cockpit procedures contributes to smoother coordination and reduced cognitive strain for ATCs.

Operational Interpretation and Discussion

From an operational perspective, the findings highlight that cockpit procedure understanding functions as a cognitive bridge between ATCs and pilots. When ATCs comprehend the procedural sequence and limitations faced by pilots, instructions can be delivered in a more realistic and operationally feasible manner. This aligns with the Swiss Cheese Model of accident causation, which emphasizes that strengthening human-system interfaces can prevent error chains from progressing into serious incidents (Perneger, 2005).

The results also reinforce prior empirical evidence suggesting that procedural understanding contributes substantially to situational awareness and decision-making effectiveness in air traffic control operations (Hendiyanto & Isnawijayani, 2024). In a complex operational environment such as ACC Jakarta, the ability to anticipate pilot actions and constraints becomes a critical component of performance quality and safety assurance.

Overall, the findings indicate that simulator-based exposure to cockpit procedures represents a strategic training approach that not only enhances individual competence but also supports systemic safety objectives within air traffic services. Strengthening such training programs may therefore contribute to sustained improvements in operational performance and aviation safety outcomes.

CONCLUSION

This study concludes that Air Traffic Controller (ATC) understanding of cockpit procedures has a significant and positive influence on ATC performance at the Area Control Centre (ACC) Unit of Jakarta Air Traffic Services Center. Enhanced procedural understanding, particularly through Flight Simulator–based training, enables ATCs to better anticipate pilot actions, deliver clearer and more operationally feasible instructions, and manage air traffic more effectively in a highly complex and dense airspace environment. The findings indicate that improved comprehension of cockpit procedures contributes to stronger situational awareness, more accurate decision-making, and smoother coordination between ATCs and pilots. Consequently, simulator-based procedural training serves not only as a technical learning tool but also as a strategic mechanism to strengthen human–system interaction and reduce the potential for communication-related errors. Overall, reinforcing ATC understanding of cockpit procedures is essential to improving operational performance and supporting sustained aviation safety within the Jakarta Flight Information Region.

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