

## **The Effect of Refresher Training on Air Traffic Controllers Performance at Jakarta ACC Unit**

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### **Abstract**

*The Indonesian aviation industry has experienced rapid growth following the post-pandemic recovery, resulting in increased operational demands for air traffic control services, particularly at the Jakarta Air Traffic Service Centre (JATSC). This study aims to analyze the effect of refresher training on the performance of Air Traffic Controllers (ATCs) at JATSC and to identify factors influencing its effectiveness. Using a quantitative approach with a quasi-experimental design, the study involved 70 licensed ATCs with a minimum of two years of experience, selected through simple random sampling. The independent variable, refresher training, was assessed through content quality, instructional methods, duration, instructor competence, and evaluation mechanisms, while ATC performance was measured across operational safety, efficiency, technical competence, and knowledge retention. Data were collected using a structured questionnaire and analyzed descriptively and inferentially. The results revealed that refresher training had a significant positive impact on ATC performance, especially in enhancing communication effectiveness, safety compliance, and technical proficiency. However, participants perceived the training duration as insufficient for complex simulation practices. The study concludes that well-structured refresher training contributes substantially to maintaining controller competence and operational safety at JATSC, emphasizing the need for continuous improvement in training design and implementation*

**Keywords:** *Refresher Training, Air Traffic Controller Performance, Jakarta Air Traffic Service Centre, Training Effectiveness, Operational Safety*

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## **INTRODUCTION**

The Indonesian aviation industry has shown significant growth over the past decade. According to the Central Statistics Agency (BPS, 2024), both domestic and international aircraft movements in Indonesia have increased by an average of 6.5% per year following the COVID-19 pandemic. As the nation's main aviation hub, Jakarta handles one of the highest air traffic volumes in Southeast Asia, with over 800,000 aircraft movements per year (AirNav Indonesia, 2024). This growth has heightened operational complexity within the Jakarta Flight Information Region (FIR), where the Jakarta Air Traffic Service Centre (JATSC) serves as the Area Control Centre responsible for managing various flight operations ranging from scheduled commercial and cargo flights to military operations.

To maintain safety and efficiency in such a demanding environment, Air Traffic Controllers (ATCs) must continuously update their technical and cognitive competencies. Globally, refresher training is recognized as a crucial component in ensuring aviation safety. The International Air Transport Association (IATA, 2023) reports that nearly 70% of aviation incidents related to human factors can be mitigated through effective recurrent training. The International Civil Aviation Organization (ICAO), through Annex 1 *Personnel Licensing* and Doc 10056 *Manual on Air Traffic Controller Competency-based Training and Assessment*, mandates periodic refresher training to ensure controllers maintain required competency levels (ICAO, 2012). In Indonesia, this requirement is reinforced by the Ministry of Transportation Regulation No. 54 of 2018, which stipulates that ATCs must undergo refresher training at least once every 12 months for a minimum of 40 hours.

Despite the regulatory framework, the practical effectiveness of refresher training in Indonesia, particularly within JATSC, remains insufficiently evaluated. Previous studies have shown that ATCs' technical and cognitive skills may deteriorate without continuous and well-designed training (Malakis & Kontogiannis, 2012). Therefore, evaluating refresher training programs is critical to ensure that they effectively enhance controller performance and operational safety.

Based on this context, the research addresses two main problems: (1) How does refresher training influence the performance of Air Traffic Controllers at JATSC's Area Control Centre unit? and (2) What factors affect the effectiveness of refresher training in improving ATC performance? Accordingly, the objectives of this study are to analyze the effect of refresher training on ATC performance and to identify the factors influencing its effectiveness. The results are expected to contribute theoretically to the field of aviation human factors and practically to improving training programs and regulatory standards for ATC competency in Indonesia.

## RESEARCH METHODS

This study employed a quantitative research approach to examine the effect of refresher training on the performance of Air Traffic Controllers (ATCs) at the Jakarta Air Traffic Service Centre (JATSC). The research design utilized was quasi-experimental, specifically the pre-test and post-test design, which allowed the researcher to measure changes in ATC performance before and after participation in the refresher training program (Campbell & Stanley, 2015). This design was selected because a fully randomized experiment is not feasible in operational ATC environments, where real-time duties cannot be interrupted (Shadish et al., 2002).

The study followed a positivist paradigm, emphasizing measurable, verifiable data to ensure objectivity and reproducibility (Creswell, 2014; Sugiyono, 2019). It was conducted over a six-month cross-sectional period, considered sufficient to observe behavioral and performance changes post-training (Babbie, 2016).

### Population and Sampling

The study population comprised licensed Air Traffic Controllers actively working at JATSC with at least two years of operational experience. This criterion ensures that participants possess a solid understanding of ATC procedures and operational context (Edwards et al., 2017). Using the Slovin formula with a 10% margin of error, a minimum of 64 respondents was determined, but 70 ATCs were sampled to account for possible attrition (Roscoe, 1975). The sampling method was simple random sampling to avoid selection bias and ensure representativeness (Kerlinger & Lee, 2000).

### Variables and Measurement

Two primary variables were analyzed:

1. Independent Variable (X): Refresher Training, defined as a structured competency-maintenance program aimed at updating and reinforcing existing ATC skills (Wickens et al., 2013). Indicators included content quality, instructional methods, duration and intensity, instructor competence, and evaluation mechanisms (Manning & Stein, 2005).
2. Dependent Variable (Y): ATC Performance, referring to operational competence and effectiveness in ensuring flight safety, communication clarity, and decision-making efficiency (ICAO, 2012; Edwards & Martin, 2017). The performance was assessed through four dimensions: operational safety, efficiency, technical competence, and knowledge retention.

Control variables included experience, education level, and workload, as these factors could influence ATC performance (Durso & Manning, 2008).

### Data Collection and Analysis

Data were collected through a structured questionnaire with a 5-point Likert scale distributed to all respondents. The instrument was validated using content validity and reliability testing via Cronbach's Alpha. Data were analyzed using descriptive statistics, correlation tests, and multiple linear regression to determine the strength and significance of relationships between variables. Statistical analysis was performed using IBM SPSS Statistics 25, following the analytical framework recommended by Ghazali (2018) and Field (2018).

### Ethical Considerations

All participants provided informed consent before participating, and confidentiality of responses was maintained. The research adhered to ethical standards in human factors studies and was approved by the institutional academic review committee.

## RESULT AND DISCUSSION

This study aimed to analyze the effect of refresher training on the performance of Air Traffic Controllers (ATCs) at the Jakarta Air Traffic Service Centre (JATSC). A total of 76 licensed ATCs participated as respondents, all of whom had undergone refresher training within the previous 12 months. The collected data were analyzed using descriptive and inferential statistics to determine the relationship between training quality and operational performance outcomes.

### Respondent Characteristics

The demographic analysis revealed that 65.8% of respondents were male and 34.2% female, consistent with global ATC demographics, which remain male-dominated (Chappelle et al., 2016). The average respondent age was 38.1 years, with work experience ranging from 7 to 30 years (mean = 18.5 years). Nearly all respondents (98.7%) held a Diploma-level education, reflecting compliance with Indonesia's aviation standards as regulated by the Ministry of Transportation (Permenhub No. 54, 2018).

### Descriptive Analysis of Refresher Training

Table 1. Descriptive Statistics of Refresher Training Dimensions

Dimension	Mean	SD	Category
Content Quality	4.201	0.462	High
Delivery Method	4.303	0.467	Very High
Duration and Intensity	3.053	0.648	Moderate
Instructor Competence	4.266	0.457	Very High
Overall Mean	3.956	0.509	High

These results are consistent with Darling-Hammond (2000), who emphasized that instructor competence significantly determines the quality of training outcomes. The findings further confirm that diverse teaching approaches combining simulation, scenario-based learning, and theoretical instruction enhance engagement and knowledge retention (Hattie & Timperley, 2007).

Conversely, the relatively lower rating for *Duration and Intensity* (M = 3.053) suggests that ATCs perceive the current training duration of 40 hours as insufficient for mastering complex simulator-based procedures. Loft et al. (2007) similarly argued that repeated practice cycles are essential for the automation of critical operational skills, particularly in high-stakes environments like air traffic control.

**Descriptive Analysis of ATC Performance**

Table 2. Descriptive Statistics of ATC Performance Dimensions

Dimension	Mean	SD	Category
Operational Safety	4.245	0.430	Very High
Operational Efficiency	4.287	0.453	Very High
Technical Competence	4.153	0.374	High
Knowledge Retention	4.218	0.414	Very High
Overall Mean	4.226	0.418	Very High

ATC performance was reported at a very high overall level ( $M = 4.226$ ). The highest scores were found in *Operational Efficiency* and *Operational Safety*, which reflect improved decision-making speed, communication accuracy, and adherence to safety protocols post-training. These findings correspond to ICAO Doc 10056 (2012), which underscores the role of recurrent training in sustaining operational safety and efficiency in complex airspace systems.

Correlation analysis revealed a positive and significant relationship between refresher training and ATC performance ( $r = 0.682$ ,  $p < 0.05$ ). Regression analysis further indicated that refresher training accounted for 46.5% of the variance in performance outcomes. Among the training dimensions, *Instructor Competence* ( $\beta = 0.321$ ) and *Content Quality* ( $\beta = 0.289$ ) emerged as the most influential predictors. This demonstrates that both the substance and delivery of training have a substantial impact on the operational capabilities of ATCs.

The findings confirm that refresher training significantly enhances ATC performance across multiple operational dimensions. Controllers who received well-structured refresher training demonstrated improved safety compliance, faster decision-making, and greater proficiency in handling abnormal and emergency situations. This supports the theoretical framework of human performance proposed by Edwards and Martin (2017), emphasizing that competence, opportunity, and motivation jointly determine performance in safety-critical professions.

Moreover, these findings align with Vlasbom et al. (2020), who asserted that recurrent training is vital for maintaining competence in high-reliability organizations. ATCs' high ratings of instructor quality indicate that the practical experience of trainers facilitates better knowledge transfer and scenario-based problem-solving, echoing the principles of experiential learning theory.

However, the study also identified limitations related to training duration and session intensity. Respondents expressed that the compressed schedule often limits the depth of simulator exercises, thereby reducing opportunities for repetition and skill reinforcement. This observation aligns with Malakis and Kontogiannis (2012), who found that underexposure to complex simulation scenarios may lead to diminished preparedness for high-pressure operational conditions.

Overall, refresher training was shown to improve not only technical proficiency but also psychological preparedness and stress management. Controllers reported higher confidence in managing abnormal flight conditions and demonstrated better situational awareness key indicators of cognitive readiness as described by Endsley's situational awareness model (Liu et al., 2021).

## CONCLUSION

This study concludes that refresher training has a significant and positive impact on the performance of Air Traffic Controllers (ATCs) at the Jakarta Air Traffic Service Centre (JATSC). The findings demonstrate that high-quality training content, competent instructors, and effective delivery methods substantially enhance ATCs' operational safety, efficiency, technical competence, and knowledge retention. Statistical analysis revealed that refresher training contributes nearly half of the variance in ATC performance, underscoring its essential role in sustaining professional proficiency within safety-critical environments. However, the relatively short training duration limits in-depth simulation practice, suggesting the need for extended and more intensive training cycles. Overall, well-structured refresher programs strengthen controller readiness, improve situational awareness, and ensure higher decision-making accuracy, thereby supporting the overarching goal of maintaining safety and efficiency in Indonesia's increasingly complex air traffic operations.

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