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Optimization of ATC Radar Simulator Utilization for Personnel Rating at Jakarta Air Traffic Service Centre

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Abstract

Aviation safety largely depends on the competence of Air Traffic Controllers (ATCs). The Jakarta Air Traffic Service Centre (JATSC), managing the Jakarta Flight Information Region (FIR), faces increasing operational complexity following the Jakarta–Singapore FIR realignment. This study aims to analyze the utilization of the ATC radar simulator in JATSC's training programs and its impact on improving ATC personnel competence. A descriptive-correlational quantitative method was applied, involving 81 ATC personnel selected through purposive sampling. Data were collected via structured questionnaires and analyzed using SPSS with validity, reliability, and correlation tests. The overall simulator utilization was categorized as high (mean = 3.87), with excellent feature quality (mean = 4.15) and strong operational relevance (mean = 3.99), though usage intensity remained moderate (mean = 2.97) due to scheduling constraints. The simulator effectively enhanced ATC competence (mean = 4.42), particularly in decision-making, workload management, situational awareness, and teamwork, while communication required improvement. Correlation results indicated that simulator feature quality had the strongest relationship with competency dimensions (r = 0.532–0.687). The study concludes that optimal simulator utilization significantly improves ATC competence, providing a strategic model for enhancing aviation training and safety.

Keywords: **ATC simulator, ICAO competency, training optimization, aviation safety, JATSC.**

INTRODUCTION

Aviation safety is one of the most essential elements in the global aviation industry and cannot be compromised under any circumstances (ICAO, 2018). Within the complex structure of air traffic operations, Air Traffic Controllers (ATCs) play a vital role in managing aircraft movement with precision and maintaining the safety and efficiency of airspace operations (Wickens et al., 2015). According to the Indonesian Aviation Law No. 1 of 2009, ATCs are responsible for preventing aircraft collisions, organizing air traffic flow, and providing flight safety information (Kementerian Perhubungan RI, 2009).

In Indonesia, the Jakarta Air Traffic Service Centre (JATSC) is responsible for managing air traffic within the Jakarta Flight Information Region (FIR) the busiest and most complex airspace in the country (AirNav Indonesia, 2023). Following the Jakarta Singapore FIR realignment in 2024, JATSC's area of responsibility expanded to more than 3 million square kilometers, increasing the demand for highly skilled and competent controllers (Sekretariat Kabinet RI, 2024).

To maintain professional standards and ensure operational safety, every ATC must hold a valid license and appropriate ratings, such as Approach Control Surveillance (APS) or Area Control Surveillance (ACS), in accordance with ICAO Annex 1 (ICAO, 2018) and CASR Part 69 (Kementerian Perhubungan RI, 2021). Developing and maintaining such competencies requires continuous training that integrates realistic and high-fidelity simulation environments.

One of the most effective tools for enhancing ATC competence is the ATC radar simulator, which allows personnel to train under realistic conditions without operational risk. Simulator-based training enables controllers to strengthen decision-making, workload

management, and situational awareness skills (Salas et al., 2009). In 2025, AirNav Indonesia implemented a new radar simulator system at JATSC to improve the quality of ATC training and align with international competency standards (AirNav Indonesia, 2025).

RESEARCH METHODS

This study applied a quantitative descriptive–correlational research design, combining descriptive analysis to depict the current condition of ATC radar simulator utilization at the Jakarta Air Traffic Service Centre (JATSC), and correlational analysis to examine the relationship between simulator usage and the improvement of ATC personnel competency. The quantitative approach was chosen to obtain objective, measurable, and generalizable findings through statistical analysis (Sugiyono, 2019).

Population and Sample

The research population consisted of all Air Traffic Controllers (ATCs) at JATSC involved in radar simulator training programs, either as trainees or instructors. Sampling was conducted using a purposive sampling technique based on the following inclusion criteria:

1. Active ATC personnel who used the simulator within the last six months;
2. Minimum of one year of operational experience as an ATC;
3. Willingness to voluntarily participate in the study.

Using the Slovin formula with a 5% margin of error, a total of 81 respondents were selected, ensuring sufficient statistical power and representativeness of the JATSC ATC population.

Operational Definitions of Variables

a. ATC Radar Simulator Usage was defined as the extent and quality of simulator utilization in ATC training programs, measured through three dimensions:
    1. *Usage Intensity* (frequency and duration of training sessions),
    2. *Feature Quality* (realism, scenario variation, and system responsiveness),
    3. *Operational Suitability* (alignment between simulator performance and real-world ATC conditions).
b. ATC Personnel Competence referred to the level of proficiency in performing ATC duties, measured based on the five ICAO competency dimensions: *situational awareness, communication, workload management, decision-making,* and *teamwork* (ICAO, 2018).
c. Optimization of Simulator Utilization represented the effort to maximize simulator effectiveness and efficiency in achieving training objectives, measured through utilization rate, curriculum alignment, instructor quality, and training outcomes.

Research Location and Period

The research was conducted at Jakarta Air Traffic Service Centre (JATSC), located within Soekarno-Hatta International Airport, Tangerang, Banten. The study took place over a four-month period, comprising one month for preparation and permission, two months for data collection, and one month for data analysis and report writing.

Data Collection Techniques

Three main data collection techniques were employed:

1. Questionnaire A structured Likert-scale (1-5) instrument consisting of 84 items measuring simulator usage, personnel competence, and training outcomes.
2. Observation Direct observation of training sessions to validate responses and record simulator operational conditions.
3. Documentation Study Analysis of secondary data, such as training reports, rating examination results, and organizational performance records.

The research instrument was tested for validity and reliability prior to full deployment, resulting in 100% valid items ($r > 0.598$) and high reliability (Cronbach's Alpha = 0.976).

Data Processing and Analysis Techniques

Data were processed and analyzed using IBM SPSS Statistics software. The analytical stages included:

1. Descriptive Statistics To summarize respondent demographics, simulator utilization levels, and competency indicators using mean scores, standard deviations, and frequency distributions.
2. Inferential Statistics
    a. Pearson Correlation Test to identify the strength and direction of relationships between simulator use and competency improvement;
    b. Multiple Linear Regression Analysis to determine the most influential simulator usage dimensions on ATC competencies.

All statistical analyses used a significance level (α) = 0.05. Interpretation of results focused on practical and operational implications rather than complex formulaic computation.

RESULT AND DISCUSSION

This section presents and discusses the findings of the study on optimizing the use of the Air Traffic Controller (ATC) radar simulator at the Jakarta Air Traffic Service Centre (JATSC). The analysis integrates quantitative results and theoretical interpretation to address the research objectives: describing the current simulator utilization condition, assessing its impact on ATC personnel competence, and identifying areas for operational improvement.

A total of 81 ATC personnel participated in this study, selected using a purposive sampling technique. Most respondents were male (58%), consistent with the gender profile in global ATC operations. The majority were assigned to Area Control Centre (ACC) units (66.7%), followed by Approach Control (22.2%) and Tower (11.1%) positions. The average age was 36.3 years, with a mean of 15.2 years of experience, indicating a mature and experienced professional group.

This demographic profile provides a strong basis for assessing simulator effectiveness through the perspectives of operationally seasoned controllers.

The questionnaire was tested using Pearson correlation for validity and Cronbach's Alpha for reliability. All items were valid ($r > 0.219$) and highly reliable ($\alpha = 0.943–0.967$), confirming that the instrument was both statistically sound and internally consistent (Louangrath & Sutanapong, 2018). This ensures credibility in measuring simulator utilization and competence indicators.

The overall condition of radar simulator use at JATSC was rated high (mean = 3.87/5), indicating positive performance yet leaving room for optimization. As shown in Figure 4.1, there is variation across three key dimensions Feature Quality, Operational Suitability, and Usage Intensity.

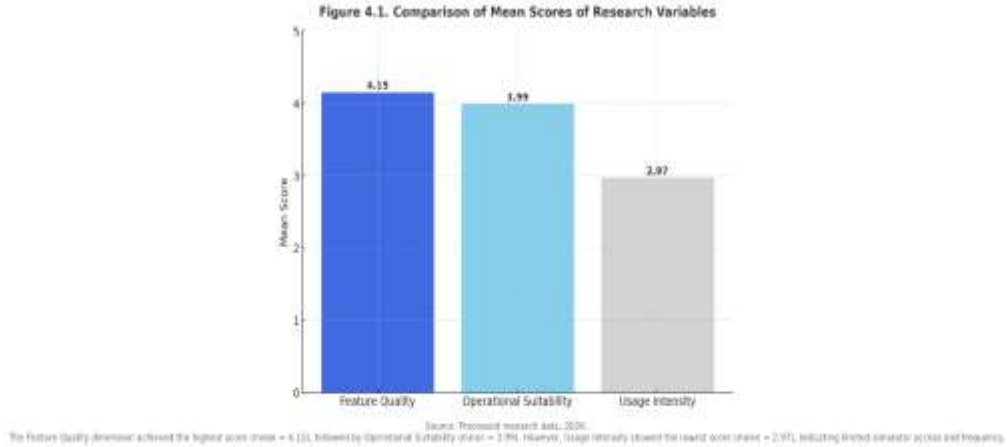

Figure 1. Comparison of Mean Scores of Research Variables

The Feature Quality dimension achieved the highest score (mean = 4.15), followed by Operational Suitability (mean = 3.99). Both demonstrate that the simulator technology aligns well with real ATC operational environments and supports realistic scenario training. However, the Usage Intensity dimension showed the lowest score (mean = 2.97), indicating limited frequency and accessibility of simulator sessions.

Further detail is shown in Table 4.1, highlighting that while most usage indicators fall within the "moderate" range (3.0–3.1), waiting time for simulator access scored the lowest (mean = 2.36), marking a significant operational bottleneck.

Table 1. Descriptive Statistics of Simulator Usage Intensity

Item	Mean	Category
Sufficient frequency of use	3.11	Moderate
Adequate session duration	3.04	Moderate
Organized scheduling	3.09	Moderate
Simulator availability	3.10	Moderate
Opportunity to practice	3.15	Moderate
Waiting time for access	2.36	Low

This finding suggests that while JATSC's simulator technology meets international standards, its utilization rate is suboptimal due to limited accessibility and scheduling inefficiency. The U.S. Federal Aviation Administration (FAA, 2024) identified similar constraints, noting that simulator availability directly affects training throughput and personnel readiness.

Impact on ATC Personnel Competence

The use of the radar simulator proved highly effective in enhancing ATC personnel competence, achieving a mean score of 4.42 (very high). Four of the five ICAO-defined competency dimensions reached "very high" categories: Decision-Making (4.52), Workload Management (4.48), Situational Awareness (4.46), and Teamwork (4.45). Only Communication scored slightly lower (4.19), mainly due to inconsistencies in the accuracy of ICAO standard phraseology (mean = 3.65).

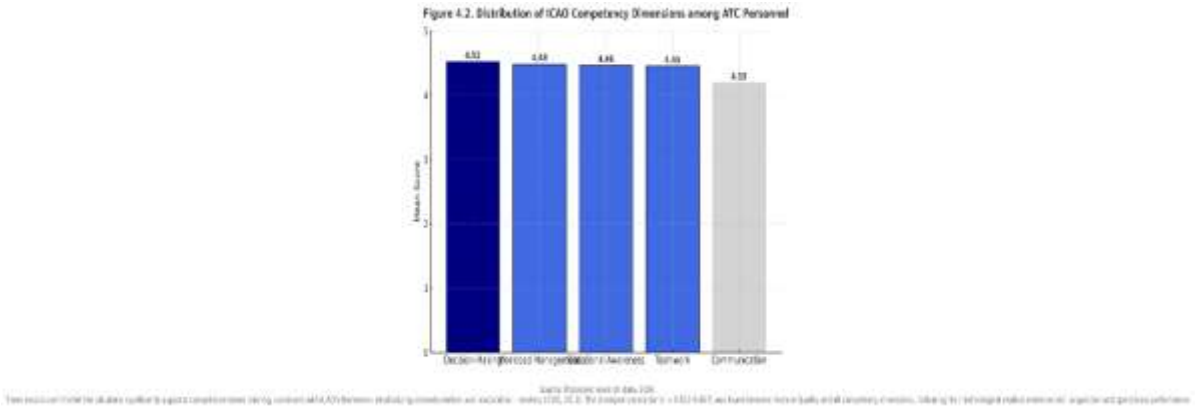

Figure 2. Distribution of ICAO Competency Dimensions among ATC Personnel

These results confirm that the simulator significantly supports competence-based training, consistent with ICAO's framework emphasizing scenario realism and practical skill mastery (ICAO, 2018). The strongest correlation (r = 0.532-0.687) was found between Feature Quality and all competency dimensions, demonstrating that technological realism directly contributes to the effectiveness of skill acquisition and operational performance.

The findings reaffirm that JATSC's simulator system has achieved technical excellence but still faces challenges in training management efficiency. The limited intensity of use mainly due to long waiting times reduces the potential benefits of an otherwise sophisticated training tool.This aligns with Salas et al. (2009), who emphasized that simulator training effectiveness depends not only on fidelity but also on structured frequency of exposure and timely feedback. Similarly, Wickens et al. (2015) found that consistent simulation exposure fosters higher retention of procedural memory and decision accuracy in high-workload environments.

The high ratings in decision-making and workload management confirm that the simulator effectively replicates dynamic and high-pressure operational contexts, enabling ATC personnel to strengthen cognitive control and risk mitigation abilities. However, the lower score in communication highlights a critical area for curriculum enhancement particularly in standard phraseology drills, which remain essential for operational safety (Manning et al., 2019).

Organizationally, the results suggest that AirNav Indonesia should enhance simulator scheduling systems, possibly by introducing an automated training allocation platform or by expanding simulator unit capacity to reduce queue times. Additionally, integrating AI-based adaptive scenarios could further personalize training experiences and maintain controller engagement (NASA, 2018; Thales, 2020).

CONCLUSION

The study concludes that the utilization of the ATC radar simulator at the Jakarta Air Traffic Service Centre (JATSC) has proven to be highly effective in enhancing the competence of air traffic controllers, particularly in the areas of decision-making, workload management, situational awareness, and teamwork. Although the simulator demonstrates strong technical quality and operational relevance, its overall optimization remains limited due to low usage intensity and scheduling constraints. The strongest positive correlation was found between simulator feature quality and ATC competence, confirming that realistic and adaptive training environments significantly contribute to skill development and operational readiness. These findings suggest that while JATSC's simulator meets international standards, improvement in access management, training frequency, and communication-focused modules is necessary to maximize its effectiveness. Therefore, optimizing simulator utilization is essential to strengthen the competency-based training framework of AirNav Indonesia and to ensure the sustainability

of safe and efficient air traffic management operations in Indonesia's increasingly complex airspace.

REFERENCES

AirNav Indonesia. (2023). *Annual air traffic report: Jakarta Flight Information Region.* AirNav Indonesia.

AirNav Indonesia. (2025). *Implementation of ATC radar simulator at JATSC.* AirNav Indonesia.

Federal Aviation Administration (FAA). (2024). *ATC training capacity and simulator utilization report.* Federal Aviation Administration.

International Civil Aviation Organization (ICAO). (2018). *Annex 1 – Personnel licensing.* Montreal: International Civil Aviation Organization.

Kementerian Perhubungan Republik Indonesia. (2009). *Undang-Undang Nomor 1 Tahun 2009 tentang Penerbangan.* Jakarta: Kementerian Perhubungan Republik Indonesia.

Kementerian Perhubungan Republik Indonesia. (2021). *CASR Part 69 – Air traffic services personnel licensing.* Directorate General of Civil Aviation.

Louangrath, P. I., & Sutanapong, C. (2018). *Statistical research methods in behavioral sciences.* Bangkok University Press.

Manning, C., Della Rocco, P., & Heil, M. (2019). ATC performance under stress and workload management. *Human Factors Journal, 61*(3), 367–379.

National Aeronautics and Space Administration (NASA). (2018). *Human factors in air traffic control simulation environments.* NASA Technical Report.

Salas, E., Bowers, C. A., & Rhodenizer, L. (2009). It's not how much you have but how you use it: Toward rational use of simulation for aviation training. *International Journal of Aviation Psychology, 9*(3), 197–208.

Sekretariat Kabinet Republik Indonesia. (2024, March). *Indonesia officially assumes control over Jakarta–Singapore FIR.* Government of Indonesia.

Sugiyono. (2019). *Metode penelitian kuantitatif, kualitatif, dan R&D.* Bandung: Alfabeta.

Thales Group. (2020). *Next-generation ATC simulation technologies.* Thales Group.

Wickens, C. D., Hollands, J. G., Banbury, S., & Parasuraman, R. (2015). *Engineering psychology and human performance* (4th ed.). New York, NY: Psychology Press.