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Relationship Analysis of Air Traffic Services System Reliability and Controller Performance at Upper Natuna JATSC

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Abstract

This study aims to analyze the relationship between the reliability of the Air Traffic Service (ATS) system and the performance of Air Traffic Controllers (ATC) in the Upper Natuna Sector at the Jakarta Air Traffic Service Center (JATSC). The increasing volume of air traffic in this strategic sector requires a highly reliable automation system to support ATC operations under high workload conditions. This research employs a quantitative correlational method using questionnaire data collected from 50 ATC personnel. Statistical analysis, including normality tests, Pearson correlation, and linear regression, was conducted using SPSS. The results reveal a very strong and positive relationship between ATS system reliability and ATC performance, with a correlation coefficient of 0.970 and a determination coefficient of 0.941. This indicates that 94.1% of ATC performance is influenced by system reliability. However, findings also show limitations in system data accuracy, leading to reduced trust and increased cognitive workload due to repeated manual verification. In conclusion, improving ATS system reliability significantly enhances ATC performance, and continuous training is essential to maintain operational effectiveness, especially during system disruptions

Keywords: Air Traffic Service System, Air Traffic Controller, System Reliability, ATC Performance, Aviation Safety

INTRODUCTION

The rapid development of globalization and technological advancement has significantly impacted the aviation industry, increasing the demand for safe and efficient transportation. In Indonesia, as an archipelagic country, air transportation plays a crucial role in connecting regions due to its ability to cover long distances in a relatively short time. Consequently, improving the quality of air navigation services particularly in terms of safety, security, and efficiency has become essential.

The increasing trend of air traffic movement, especially after the COVID-19 pandemic recovery period, has led to higher operational demands on Air Traffic Services (ATS). This condition requires reliable automation systems to support Air Traffic Controllers (ATC) in managing complex and dynamic air traffic situations. Automation systems are designed to assist controllers in monitoring, decision-making, and reducing workload, thereby improving operational performance (Bestugin et al., 2020). However, excessive reliance on automation may reduce situation awareness, particularly under high traffic density conditions (Mirchi et al., 2015).

Previous studies highlight that ATC performance is influenced by workload, fatigue, and situation awareness, all of which are closely related to the level of automation usage (Edwards et al., 2016). Additionally, the implementation of surveillance technologies such as ADS-B has improved operational accuracy, although system reliability remains dependent on infrastructure and adequate training (Pradana, 2023). Furthermore, system failures can significantly affect ATC performance and aviation safety (Li et al., 2017).

In the context of the Jakarta Air Traffic Service Center (JATSC), particularly in the Upper Natuna Sector, the high volume of international and domestic flights requires optimal system performance. However, challenges such as unstable radar data due to extreme topography can

trigger false alarms (Short Term Conflict Alert), leading to alarm fatigue and increased cognitive workload for ATC. This condition may reduce vigilance and negatively impact controller performance, potentially compromising flight safety.

Based on these conditions, it is important to examine the relationship between the reliability of the Air Traffic Service System and the performance of Air Traffic Controllers.

RESEARCH METHODS

This study employed a quantitative correlational research design to examine the relationship between the reliability of the Air Traffic Service (ATS) system and the performance of Air Traffic Controllers (ATC) in the Upper Natuna Sector at the Jakarta Air Traffic Service Center (JATSC) . Correlational research is used to determine the degree of association between variables without manipulating them (Aminarno, 2015).

Research Subjects and Materials

The subjects of this study were Air Traffic Controllers (ATC) working at the Area Control Center (ACC) unit of Perum LPPNPI, JATSC, who hold an Area Control Surveillance (ACS) rating. The total population consisted of 240 ATC personnel, and a sample of 50 respondents (20%) was selected based on Arikunto's sampling guideline (Arikunto, 2019) .

The primary research materials included questionnaire instruments designed to measure two variables:

1. Reliability of the Air Traffic Service System
2. Performance of Air Traffic Controllers

Research Design and Variables

This study applied a correlational design with two variables:

1. Independent variable (X): Reliability of the Air Traffic Service System
2. Dependent variable (Y): Performance of Air Traffic Controller

Both variables were operationalized using structured indicators derived from ATS system standards (Doc. 9426) and human factors references (Human Factors Digest 11) .

Sampling Technique

A proportional sampling approach was used, selecting 20% of the total population, resulting in 50 respondents. This approach follows established sampling guidelines for large populations (Arikunto, 2019).

Data Collection Techniques

Data were collected using the following methods:

1. Observation, direct observation was conducted to understand operational conditions in the Upper Natuna Sector.
2. Questionnaire, the main instrument consisted of 20 items (10 for each variable) using a Likert scale ranging from strongly disagree (1) to strongly agree (5) (Sugiyono, 2019).

The questionnaire measured perceptions, attitudes, and experiences of ATC regarding system reliability and performance.

Data Analysis Techniques

Data analysis was conducted using Microsoft Excel and SPSS version 25 . The following statistical methods were applied:

1. Normality Test (Shapiro-Wilk) to ensure data distribution assumptions
2. Pearson Product Moment Correlation to measure the strength and direction of the relationship between variables (Sugiyono, 2019)
3. Simple Linear Regression Analysis to determine the effect of ATS system reliability on ATC performance
4. Coefficient of Determination (R^2) to assess the contribution of the independent variable

5. t-test (partial hypothesis test) to evaluate statistical significance (Ghozali, 2011)

These methods are widely used in quantitative research to analyze relationships between variables and test hypotheses without excessive reliance on complex statistical formulas.

RESULT AND DISCUSSION

This study examines the relationship between the reliability of the Air Traffic Service (ATS) system and the performance of Air Traffic Controllers (ATC) in the Upper Natuna Sector, Jakarta Air Traffic Service Center (JATSC). The findings are presented in an integrated manner to highlight both empirical results and their interpretation within operational and theoretical contexts.

Table 1. Mean scores of ATS system reliability dimensions

Indicator	Description	Mean
X1	Aircraft position accuracy	3.12
X2	Flight data reliability	2.62
X3	Interface usability	2.70
X4	Operational ease	2.70
X5	Decision support capability	2.92
X6	Conflict alert effectiveness	2.74
X7	System stability	2.94
X8	System disturbance frequency	2.92
X9	Workload reduction capability	3.20
X10	Inter-sector coordination support	3.08

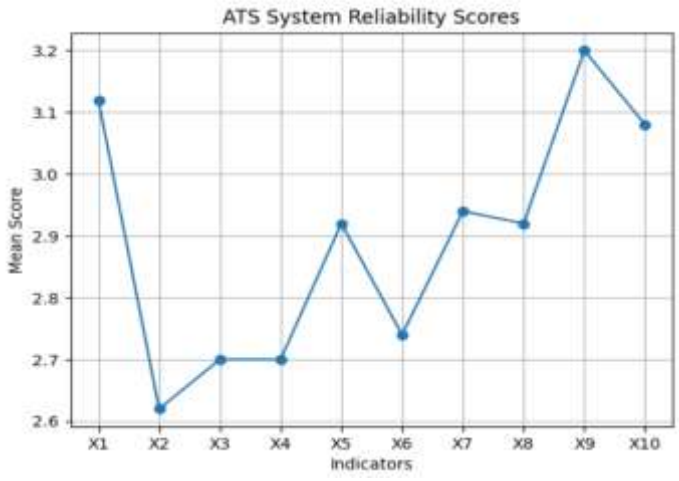

Figure 1. ATS system reliability profile
Description: Distribution of mean scores across ATS reliability indicators.

The reliability of the ATS system shows moderate performance, with mean values ranging from 2.62 to 3.20. The highest score appears in the system's ability to reduce controller workload during high traffic conditions (X9), indicating that automation contributes positively to operational efficiency. This aligns with the concept that automation reduces workload and enhances task execution efficiency (Bestugin et al., 2020).

However, the relatively lower score in flight data reliability (X2) suggests inconsistency in system output, which is critical in surveillance-based operations. From an operational perspective, reliability is not only determined by system availability but also by data integrity and accuracy displayed to controllers (ICAO Doc. 9426). Variability in responses also indicates differing user experiences, likely influenced by traffic complexity and system behavior in the Upper Natuna sector, which is known for radar limitations due to geographical conditions .

Table 2. Mean scores of ATC performance dimensions

Indicator	Description	Mean
Y1	Situational awareness	3.10
Y2	Critical system monitoring	2.78
Y3	Motivation and satisfaction	2.82
Y4	Manual operation capability	3.08
Y5	Decision authority	2.74
Y6	Monitoring fatigue	2.96
Y7	Training adequacy	2.92
Y8	Trust in system data	2.52
Y9	Cognitive workload	2.74
Y10	Coordination effectiveness	3.22

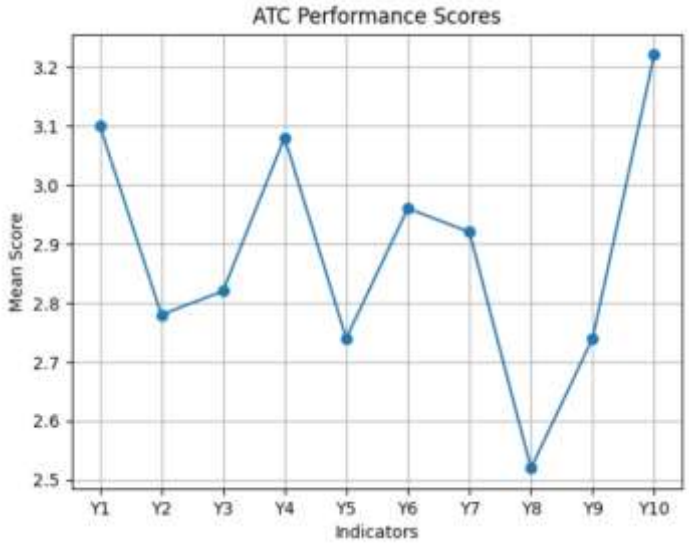

Figure 2. ATC performance profile

Description: Distribution of mean scores across ATC performance indicators.

ATC performance indicators also fall within a moderate range (2.52 - 3.22). The strongest aspect is coordination among controllers (Y10), indicating that teamwork remains effective despite increasing reliance on automation. This supports the notion that human collaboration remains a key component in air traffic management systems (ICAO Annex 11).

Conversely, the lowest score is found in trust in system data (Y8), reflecting skepticism toward automation outputs. This condition suggests the presence of operational distrust, where controllers rely on manual verification despite automated support. Such findings are consistent with previous studies indicating that excessive reliance or mistrust in automation can affect situational awareness and performance (Mirchi et al., 2015).

The moderate score in cognitive workload (Y9) further indicates that automation does not always reduce mental effort, particularly when system inconsistencies occur. This supports the argument that automation may introduce new types of workload, especially under high traffic conditions and system anomalies (Edwards et al., 2016).

Relationship Between ATS System Reliability and ATC Performance

Statistical analysis confirms a strong positive relationship between ATS system reliability and ATC performance. The correlation coefficient ($r = 0.970$) indicates a very strong association, meaning improvements in system reliability are closely followed by improvements in controller performance .

The regression model further demonstrates that system reliability is a dominant predictor of performance, explaining approximately 94.1% of performance variation. This highlights the critical role of automation systems in shaping operational outcomes in modern air traffic environments.

From an operational standpoint, this relationship reflects the dependency of ATC performance on system support, particularly in high-density airspace such as Upper Natuna. Reliable automation enhances decision-making speed, reduces uncertainty, and supports conflict detection processes. However, when reliability is compromised, controllers experience increased cognitive load and reduced confidence, potentially affecting safety margins.

The findings emphasize the dual role of automation in air traffic control: as both a performance enhancer and a potential source of operational risk. While automation improves efficiency and workload management, its effectiveness depends heavily on system reliability and user trust.

In the context of Upper Natuna, environmental constraints such as radar coverage limitations contribute to unstable surveillance data, which may trigger false alerts (e.g., STCA). This condition can lead to alarm fatigue, reducing controller sensitivity to critical warnings . Such phenomena highlight the importance of balancing automation with human oversight, as suggested in Human Factors Digest No. 11.

Furthermore, the results reinforce that training plays a crucial role in maintaining performance. Controllers must not only operate automated systems but also retain manual skills and critical thinking abilities to handle system failures effectively. This aligns with ICAO recommendations that automation should support, not replace, human decision-making.

Overall, the study demonstrates that improving ATS system reliability particularly in data accuracy and system stability can significantly enhance ATC performance. At the same time, strengthening training programs and mitigating over-reliance on automation are essential to ensure sustainable operational safety.

CONCLUSION

The findings indicate that the reliability of the Air Traffic Service (ATS) system plays a decisive role in shaping Air Traffic Controller (ATC) performance in the Upper Natuna Sector, where higher system consistency is associated with more effective operational outcomes, particularly in coordination, situational awareness, and decision-making. Despite the overall functional contribution of automation in supporting workload management, limitations in data accuracy and system stability reduce user trust and introduce additional cognitive demands, highlighting the complex interaction between human operators and automated systems. The strong alignment between system reliability and performance suggests that improving technical robustness especially in surveillance data integrity can significantly enhance operational effectiveness. At the same time, maintaining controller competence through continuous training and preserving manual operational skills remains essential to ensure resilience in the face of system limitations, thereby supporting sustained aviation safety and efficiency.

REFERENCES

Arikunto, S. (2019). Prosedur penelitian: Suatu pendekatan praktik. Rineka Cipta.

Aminarno. (2015). Metodologi penelitian. Yogyakarta: Pustaka Pelajar.

Bestugin, A. V., Pavlenko, D. V., Konyukh, A. I., & Solovyev, I. V. (2020). *Air traffic control automation: Issues and development. Civil Aviation High Technologies*, 23(1), 45–53.

Edwards, T., Sharples, S., Wilson, J., & Kirwan, B. (2016). *The interaction of situation awareness and workload in association with automation. Theoretical Issues in Ergonomics Science*, 17(2), 200–220.

International Civil Aviation Organization. (1998). Annex *11 to the Convention on International Civil Aviation: Air traffic services*. ICAO.

International Civil Aviation Organization. (1984). Doc 9426: *Air traffic service planning manual*. ICAO.

Li, X., Zhang, Y., & Chen, L. (2017*). Effects of automation failures on air traffic controllers' performance. Journal of Air Transport Management*, 62, 109–118.

Mirchi, T., Vu, K. P. L., Miles, J., Sturre, L., Curtis, S., & Strybel, T. Z. (2015). *Air traffic controller trust in automation in NextGen. Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 59(1), 46–50.

Pradana, R. (2023). Evaluasi implementasi ADS-B dalam meningkatkan kinerja pengawasan lalu lintas udara di Indonesia. Jurnal Penerbangan, 14(1), 22–35.

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