

The Influence of Occupational Health on Operational Performance at the ACC Jakarta Air Traffic Service Centre

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Abstract

This study investigates the influence of occupational health on operational performance among Air Traffic Controllers (ATCs) at the Area Control Centre (ACC) Unit of Jakarta Air Traffic Service Centre (JATSC). The research aims to identify how physical and mental health conditions such as fatigue, stress, and workload affect ATC performance in managing air traffic operations. Using a quantitative descriptive-correlational approach, data were collected through observation, documentation, and questionnaires distributed to 77 respondents selected purposively from a population of 238 ATCs. Data were analyzed using SPSS software, employing descriptive statistics, Pearson correlation, and multiple linear regression. The results show a significant positive relationship between occupational health and operational performance, with fatigue and stress emerging as dominant factors affecting performance levels. Healthy ATCs demonstrated higher alertness, communication accuracy, and decision-making speed, all of which are crucial for maintaining operational safety. The findings highlight that effective occupational health management contributes not only to individual well-being but also to the overall safety and efficiency of air navigation services. The study recommends that AirNav Indonesia enhance fatigue management systems and implement health-oriented scheduling policies to optimize controller performance and ensure sustainable aviation safety.

Keywords: Occupational Health, Performance, Air Traffic Controller, Fatigue, Safety

INTRODUCTION

The aviation sector in Indonesia continues to experience significant growth, with approximately 155.9 million passengers served in 2024 across 37 airports, an increase of 4% from the previous year (Liputan6.com, 2025). During the 2024/2025 Christmas and New Year period, air transport carried over 3.8 million passengers, marking a 10.2% increase compared to the same period in the previous year (Directorate General of Civil Aviation, 2024). This increasing passenger volume underscores the escalating operational complexity and workload intensity in the air navigation sector.

Among aviation professionals, Air Traffic Controllers (ATCs) bear one of the most demanding roles, requiring precision, sustained concentration, and rapid decision-making. Their duties encompass managing arrivals, departures, approaches, and in-flight coordination, ensuring safety and efficiency within constrained airspace. According to the International Civil Aviation Organization (ICAO, 2018), psychological stress is a major factor affecting individual performance in aviation operations. When unmanaged, such stress can trigger fatigue and human errors that compromise flight safety.

In the context of Jakarta Air Traffic Service Centre (JATSC), one of the busiest air navigation hubs in Southeast Asia, ATCs operate under rotating shifts including nights and weekends that disrupt circadian rhythms, leading to chronic fatigue and stress (Çoban, 2025). Persistent exposure to these conditions without adequate intervention can deteriorate occupational health and operational performance. The Dirty Dozen of Human Factors framework identifies fatigue, stress, pressure, and lack of situational awareness among the leading causes of performance degradation in aviation safety (Çoban, 2025).

Furthermore, maintaining occupational health is not only vital for individual well-being but also a strategic component of the Safety Management System (SMS), as highlighted by ICAO Doc 9859 (2018). Studies such as Young et al. (2015) emphasize the importance of integrating cognitive ergonomics, work psychology, and organizational safety management to mitigate performance decline in high-stress operational environments.

Despite the criticality of these factors, research exploring ATC perceptions of occupational health and its direct impact on performance remains limited in Indonesia. Most studies focus on physiological or technical aspects without integrating subjective perceptions from operational personnel. Thus, this research seeks to bridge that gap.

Problem Statement

Based on the background above, the problems identified are:

1. How do Air Traffic Controllers perceive their occupational health conditions at the ACC Jakarta Air Traffic Service Centre?
2. To what extent does occupational health affect their operational performance?

Research Objectives

This study aims to:

1. Identify and describe ATC perceptions of their occupational health conditions at ACC Jakarta.
2. Analyze the influence of occupational health, both physical and mental, on the operational performance of ATCs at the ACC Jakarta Air Traffic Service Centre

RESEARCH METHODS

This research employed a quantitative approach with a descriptive-correlational design. The quantitative method was selected because the data were expressed numerically and analyzed statistically to obtain objective and measurable findings (Sugiyono, 2019). The descriptive design was used to provide an overview of the occupational health conditions both physical and mental of Air Traffic Controller (ATC) personnel, while the correlational aspect was intended to examine the relationship between occupational health (X) and operational performance (Y) without manipulating the research variables (Creswell & Creswell, 2018).

This design was deemed appropriate because the study did not aim to identify causality but rather to explore the relationship strength and direction between the two variables based on empirical data (Cooper & Schindler, 2014). Through this method, the researcher aimed to determine the extent to which variations in occupational health are associated with variations in ATC operational performance at the Jakarta Air Traffic Service Centre (JATSC).

Population and Sample

The research population comprised 238 active ATCs at the Jakarta Area Control Centre (ACC). The sample size was determined using the Slovin formula with a 10% margin of error, resulting in a minimum of 70 respondents. To account for potential non-responses, the final sample size was expanded to 77 respondents.

Sampling was conducted using purposive sampling, a non-probability technique in which participants were selected based on specific criteria relevant to the study (Patton, 2002). The criteria included:

1. Active duty as an ATC at ACC Jakarta;
2. Minimum of two years of professional experience;
3. Age between 25 and 45 years;
4. Involvement in rotating or night shift schedules; and
5. Willingness to voluntarily participate in the study.

Operational Definition of Variables

1. Occupational Health (X): Refers to the physical and mental well-being of ATCs as influenced by workload, shift system, and work environment. It includes indicators such as fatigue, stress, pressure, and situational awareness, consistent with the Dirty Dozen of Human Factors model (Çoban, 2025).
2. Operational Performance (Y): Represents ATC effectiveness and efficiency in ensuring flight safety through accurate communication, decision-making, and compliance with standard operating procedures (Mangkunegara, 2013).

Data Collection Techniques

Three main data collection methods were employed: observation, documentation, and questionnaires.

1. Observation was conducted in a non-participatory manner to capture the actual working environment of ATCs, including their behavioral patterns during peak hours and shift rotations (Sugiyono, 2010).
2. Documentation involved the examination of organizational records such as shift schedules, fatigue reports, and internal safety policies to provide contextual support (Creswell & Poth, 2016).
3. Questionnaires served as the primary instrument, consisting of Likert-scale items measuring respondents' perceptions of occupational health and operational performance. The instrument was structured around two dimensions physical and mental health mapped to eight of the twelve Dirty Dozen factors, ensuring both validity and contextual relevance (Çoban, 2025).

Data Analysis Techniques

Data were analyzed using SPSS version 25. Descriptive statistics were applied to summarize respondent characteristics and variable distributions. To test relationships between variables, Pearson correlation analysis and multiple linear regression were conducted.

Instrument validity was assessed using the Product-Moment Correlation, while Cronbach's Alpha determined internal consistency reliability (Ghozali, 2018). Furthermore, Kolmogorov-Smirnov tests verified data normality, ensuring that the regression assumptions were satisfied. Statistical significance was established at the 0.05 level.

The analysis aimed to determine the degree to which occupational health influences ATC operational performance, providing both theoretical and managerial implications for AirNav Indonesia's safety management and human resource policies.

RESULT AND DISCUSSION

The research involved 77 Air Traffic Controllers (ATCs) from the Jakarta Air Traffic Service Centre (JATSC), representing a proportional distribution of experience levels, gender, and age. The majority of respondents (68%) had more than five years of professional experience, indicating a well-established operational familiarity with complex airspace management tasks. Most participants (83%) reported working under a rotating shift system, including night shifts, which aligns with the operational realities of 24-hour air navigation service provision.

This demographic distribution validates the suitability of the sample in representing the diverse working conditions and occupational health status of ATCs in Jakarta FIR, particularly regarding shift-related fatigue and mental workload (Stanton et al., 2019).

Instrument Validity and Reliability

The instrument validity test confirmed that all questionnaire items achieved correlation coefficients exceeding the threshold of $r = 0.300$, indicating that every item effectively measured the intended construct (Ghozali, 2018). Reliability analysis further showed that all variables

achieved Cronbach's Alpha values above 0.7, confirming internal consistency. These findings substantiate the dependability of the data collection instrument in capturing both occupational health and performance dimensions (Nunnally & Bernstein, 1994).

Descriptive Findings

Based on descriptive analysis, respondents generally perceived their occupational health conditions as "good," with an average score of 4.05 on a five-point Likert scale. However, dimensions such as fatigue (3.62) and stress (3.71) scored lower than physical health indicators (4.15), suggesting that mental health challenges remain more prevalent.

In terms of operational performance, ATCs rated their own work performance as "very good" (mean = 4.22), particularly in aspects of decision accuracy and communication precision core indicators of air traffic service quality (Mangkunegara, 2013).

These results highlight that, although physical conditions such as workspace ergonomics and rest management are well-handled, psychological demands stemming from workload intensity and continuous operational vigilance still exert significant pressure on ATCs.

Relationship between Occupational Health and Performance

Table 1. Correlation between Occupational Health and Operational Performance

Variable	Pearson Correlation (r)	Sig. (2-tailed)
Occupational Health - Performance	0.598	0.000

The results indicate a strong positive correlation ($r = 0.598$, $p < 0.05$) between occupational health and operational performance. This confirms that better physical and mental health conditions among ATCs are associated with higher performance levels, particularly in maintaining concentration and communication clarity.

These findings align with the framework of Human Factors Theory, particularly the Dirty Dozen Model proposed by Çoban (2025), which identifies fatigue, stress, and pressure as primary determinants of human error in aviation safety systems. The observed correlation reinforces that proactive occupational health management through rest scheduling, workload balancing, and psychological support directly enhances cognitive and operational efficiency.

Regression Analysis and Interpretive Insights

The multiple regression analysis demonstrated that occupational health variables (both physical and mental) jointly explained approximately 36% of the variance in operational performance. Among the sub-variables, mental health exhibited the highest standardized coefficient ($\beta = 0.421$), suggesting that psychological stability, stress management, and situational awareness are key performance predictors for ATCs.

The F-test results confirmed that the regression model was statistically significant ($p < 0.05$), validating that occupational health, as a composite factor, exerts a meaningful influence on operational outcomes (Sugiyono, 2019).

The findings align with prior studies by Neal et al. (2000) and Saleh (2017), which emphasize that organizational safety performance is inseparable from individual health conditions and alertness. Furthermore, ICAO (2018) underlines in its *Safety Management Manual (Doc 9859)* that fatigue mitigation and well-being programs are essential to ensure operational resilience in continuous service environments.

Interpretation and Theoretical Implications

The relationship pattern observed in this study validates the theoretical premise that occupational health functions as a mediating variable between workload and performance quality. When the balance between physiological endurance and psychological resilience is maintained, ATCs exhibit superior performance consistency, reduced communication errors, and enhanced situational awareness.

Conversely, chronic fatigue or unmanaged stress can disrupt decision-making processes, consistent with Stanton et al. (2019) who note that cognitive fatigue reduces reaction accuracy in time-critical control tasks. Similarly, Young et al. (2015) assert that cognitive ergonomics when integrated into work scheduling and recovery systems can significantly mitigate fatigue-induced performance decline.

In the operational context of JATSC, where controllers handle one of Southeast Asia's busiest flight information regions, these findings stress the necessity for structured Fatigue Risk Management Systems (FRMS) as recommended by ICAO Doc 9966 (2016). The implementation of FRMS, supported by real-time fatigue monitoring and duty-time regulation, can serve as a strategic approach to sustain ATC well-being and maintain safety margins.

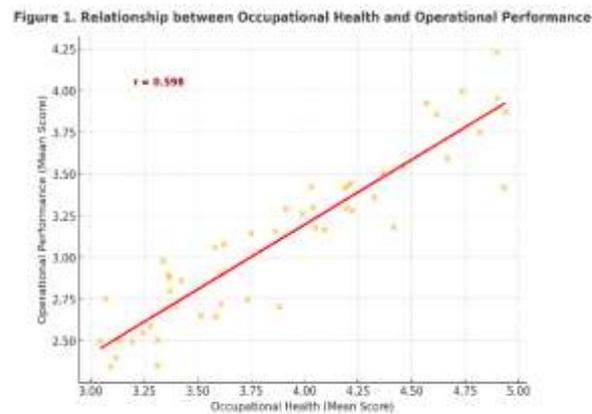


Figure 1. Relationship between Occupational Health and Operational Performance

This graphical relationship confirms a clear upward trend, implying that improvements in health-related factors, both physical and psychological, contribute to better operational precision, communication reliability, and task execution speed.

Practical Implications

The results provide actionable insights for AirNav Indonesia and similar air navigation service providers. Maintaining holistic occupational health programs, including physical fitness checks, mental resilience workshops, ergonomic workspace improvements, and shift rotation optimization, will yield direct operational benefits. These initiatives can prevent cognitive fatigue accumulation, reduce human error probability, and enhance organizational safety culture (Çoban, 2025; ICAO, 2018).

Moreover, promoting open communication and psychological safety among ATCs is essential to encourage assertiveness and early reporting of fatigue-related symptoms factors recognized in the Dirty Dozen model as critical to mitigating human error risks.

CONCLUSION

Based on the analysis and discussion of the research on the influence of occupational health on the performance of Air Traffic Controllers (ATC) at the Jakarta Air Traffic Service Centre (ACC Unit), it can be concluded that occupational health has a significant impact on operational performance. The better the physical and mental condition of ATCs, the higher their accuracy, reliability, and performance stability in managing air traffic operations, confirming that occupational health is a crucial component in maintaining the quality of air navigation services. Both physical and mental health aspects play a vital role in shaping ATC performance dynamics,

as fatigue caused by shift systems, operational pressure, and workload intensity can affect focus, psychological endurance, and decision-making accuracy. The findings also reveal the interrelation between occupational health and key human factors within the *Dirty Dozen* framework such as fatigue, stress, pressure, and distraction which, if not properly managed, may increase the risk of human error. Overall, the study emphasizes that occupational health is not merely a matter of employee welfare but a strategic element in supporting ATC performance and ensuring aviation safety standards.

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