

THE EFFECT OF SOCIAL WORK ENVIRONMENT ON CNSD EQUIPMENT OPERATIONAL RELIABILITY AT SOEKARNO-HATTA AIRPORT

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Received: 2026-07-20

Accepted: 2026-10-27

Published: 2026-10-30

Abstract

This study aimed to examine the effect of the social work environment of air navigation technicians on the operational reliability of Communication, Navigation, Surveillance and Data (CNSD) equipment at Soekarno-Hatta International Airport. The study employed a quantitative approach with an associative survey method. The population consisted of 55 air navigation technicians of the CNSD Technical Unit at Perum LPPNPI (AirNav Indonesia) Jakarta Air Traffic Service Center, and all 55 technicians were selected as respondents through simple random sampling. Primary data were collected through a five-point Likert-scale questionnaire distributed online, complemented by secondary data from maintenance logbooks and fault records. The data were analyzed using simple linear regression after validity, reliability, and classical assumption tests were conducted. The results showed that eight of ten items of the social work environment variable were valid, with a Cronbach's Alpha of 0.917, while all eight items of the equipment reliability variable were valid, with a Cronbach's Alpha of 0.885. The regression equation obtained was $Y = 14.378 + 0.611X$, with a t-value of 7.496 and a significance value of 0.000, and an F-value of 56.189 with a significance value of 0.000, indicating a positive and significant effect. The coefficient of determination was 0.515, meaning the social work environment explained 51.5 percent of the variation in CNSD equipment operational reliability, while the remaining 48.5 percent was explained by other factors. These findings implied that strengthening technical communication, team coordination, and supervisory support can enhance the operational reliability of CNSD equipment and support safe and continuous flight navigation services.

Keywords: Technical Communication, Social Work Environment, Equipment Reliability, CNSD, Air Navigation Technicians

1. Introduction

Flight safety is a primary concern in the aviation industry, and one of its key pillars is the reliability of the Communication, Navigation, Surveillance and Data (CNSD) system. This system comprises aviation navigation and communication equipment such as the Instrument Landing System (ILS), Distance Measuring Equipment (DME), Doppler Very High Frequency Omnidirectional Range (DVOR), primary and secondary radar, and Automatic Dependent Surveillance–Broadcast (ADS-B), together with supporting communication facilities. The operational reliability of this equipment is essential to guarantee the safety, orderliness, and efficiency of air traffic. According to the International Civil Aviation Organization (ICAO), CNSD systems must operate optimally because of their critical role in supporting international air navigation services. ICAO Annex 10 requires CNSD systems to maintain a high level of availability, reliability, continuity, and integrity. Beyond technical aspects, ICAO also emphasizes the



importance of human factors, including communication, coordination, teamwork, and the working conditions of technical personnel who operate and maintain navigation equipment (ICAO, 2018).

Air navigation technicians hold direct responsibility for operating, maintaining, and handling disturbances in CNSD equipment. Their effectiveness depends not only on technical competence but also on the social work environment, which includes communication among personnel, technical coordination within teams, working relationships with supervisors, and openness of information during maintenance and fault-handling activities. Research on human factors indicates that most operational disturbances in critical systems are influenced by human factors, including miscommunication and weak work coordination (Reason, 1990).

Preliminary observation of the CNSD Technical Unit at Soekarno-Hatta International Airport revealed several obstacles in technical communication and coordination among personnel that potentially affect the effectiveness of fault handling, including limited cross-unit communication and the absence of direct communication access with related technical parties. Such conditions lengthen the coordination process, increase the Mean Time to Repair (MTTR), and may reduce equipment availability. Miscommunication within technical organizations is known to slow decision-making and fault-recovery processes (Fajriati & Noviyanty, 2024; Robbins & Judge, 2022). This condition is increasingly important given that Soekarno-Hatta International Airport is among the busiest airports in Indonesia, serving tens of millions of passengers annually with a very high rate of aircraft movement (PT Angkasa Pura II, 2023), which requires the CNSD system to remain reliable and continuously ready to operate.

Previous studies, such as that of Fajriati and Noviyanty (2024) on the Airport Operation Center (AOC) unit at Soekarno-Hatta Airport, showed that the work environment and social relationships positively affect operational work effectiveness. However, prior research has generally examined the effect of the work environment on employee performance or organizational effectiveness in general, and studies specifically linking the social work environment to the operational reliability of CNSD equipment particularly measured through reliability-engineering indicators such as availability, MTBF, and MTTR remain limited.

The urgency of this research is driven by several critical factors. First, flight safety is a primary concern in the aviation industry, and one of its key pillars is the reliability of the CNSD system, yet empirical evidence on how the social work environment influences the operational reliability of CNSD equipment remains limited. Second, air navigation technicians hold direct responsibility for operating, maintaining, and handling disturbances in CNSD equipment, yet their effectiveness depends not only on technical competence but also on the social work environment, which includes communication, coordination, working relationships, and openness of information. Third, preliminary observation at Soekarno-Hatta International Airport revealed obstacles in technical communication and coordination among personnel that potentially affect the effectiveness of fault handling, lengthen the coordination process, and increase the Mean Time to Repair. Fourth, Soekarno-Hatta International Airport is among the busiest airports in Indonesia, serving tens of millions of passengers annually with a very high rate of aircraft movement, requiring the CNSD system to remain reliable and continuously ready to operate. Fifth, prior research has generally examined the effect of the work environment on employee performance or organizational effectiveness in general, and studies specifically linking the social work environment to the operational reliability of



CNSD equipment particularly measured through reliability-engineering indicators such as availability, MTBF, and MTTR remain limited.

Previous research has shown significant but fragmented findings regarding the determinants of operational reliability in aviation systems. Studies have demonstrated that effective communication and coordination are key factors in maintaining the safety and reliability of high-technology systems, since most errors in complex systems, including flight navigation systems, originate from failures in communication and coordination among personnel (Salas et al., 2015). Research has shown that human error is a latent factor behind accidents in high-risk systems, with miscommunication and weak work coordination being among the most influential human factors (Reason, 1990). Research has also shown that the work environment and social relationships significantly affect the operational performance of aviation ground units (Fajriati & Noviyanty, 2024). However, studies specifically linking the social work environment to the operational reliability of CNSD equipment remain limited, particularly in the context of Soekarno-Hatta International Airport.

The research gap in this study lies in the limited understanding of how the social work environment influences the operational reliability of CNSD equipment, particularly in the context of air navigation technicians at Soekarno-Hatta International Airport. While individual studies have examined the effect of the work environment on employee performance or organizational effectiveness, the integrated framework connecting the social work environment with reliability-engineering indicators such as availability, MTBF, and MTTR remains underexplored (Fajriati & Noviyanty, 2024; Robbins & Judge, 2022; Salas et al., 2015). Additionally, most previous studies have focused on general employee performance or organizational effectiveness, leaving a significant gap in knowledge regarding the dynamics of CNSD equipment operational reliability at Soekarno-Hatta International Airport. Furthermore, empirical evidence on the determinants of equipment operational reliability in Indonesia remains limited, particularly in the context of increasing air traffic and evolving human-factors practices.

The novelty of this research lies in several aspects. First, this study focuses on the CNSD Technical Unit at Soekarno-Hatta International Airport during the April–May 2026 period, representing a unique context characterized by high air traffic density and critical navigation service continuity. Second, this study develops an integrative model that examines the influence of the social work environment on the operational reliability of CNSD equipment, providing a more comprehensive understanding of the determinants of equipment reliability in the aviation sector. Third, this study contributes to the limited empirical evidence on the relationship between the social work environment and equipment operational reliability, providing insights into how communication, coordination, and supervisory support collectively influence equipment reliability. Fourth, this study extends the application of human factors theory and organizational behavior theory to the context of CNSD equipment operational reliability in Indonesia, validating theoretical predictions in an under-researched institutional context. Fifth, this study provides actionable insights for air navigation technicians, unit managers, and aviation regulators in designing effective strategies to enhance equipment reliability and support safe and continuous flight navigation services.

The purpose of this study is to analyze the condition of the social work environment of air navigation technicians and to examine its effect on the operational reliability of CNSD equipment at Soekarno-Hatta International Airport. Specifically, this research aims to analyze the condition of the social work environment of air navigation technicians



and to examine the effect of the social work environment on the operational reliability of CNSD equipment. The choice of this goal was driven by the limited understanding of how the social work environment influences equipment operational reliability and the need for empirical evidence that can inform air navigation technicians, unit managers, and aviation regulators in designing effective strategies to enhance equipment reliability and support safe and continuous flight navigation services.

The contribution of this research is multifaceted. From a theoretical perspective, this research contributes to the enrichment of literature on human factors and organizational behavior by proposing and testing an integrative model that links the social work environment with CNSD equipment operational reliability, extending the application of human factors theory and organizational behavior theory to the context of aviation navigation services in Indonesia. The findings contribute to the understanding of how the social work environment influences equipment operational reliability, providing a more nuanced theoretical framework for analyzing human-factors determinants of equipment reliability in the aviation sector. From a practical perspective, this study provides actionable insights for air navigation technicians, unit managers, and aviation regulators in assessing and managing equipment reliability. For air navigation technicians, the findings provide guidance on which social work environment factors should be considered in maintaining equipment reliability. For unit managers, the results offer insights into the factors affecting equipment reliability and the importance of strengthening technical communication, team coordination, and supervisory support. For aviation regulators, this study provides empirical evidence to support the development of policies to maintain flight safety and service continuity. For academics, this study contributes to the growing body of literature on human factors and equipment reliability, providing a foundation for future research on the social work environment, equipment reliability, and aviation safety.

2. Theoretical Background

2.1 Human Factors Theory

Human Factors Theory explains that the safety and reliability of complex, high-technology systems depend not only on technical aspects but also on human performance, including communication, coordination, teamwork, and working conditions (Salas et al., 2015). In this study, the social work environment encompassing communication among personnel, technical coordination within teams, working relationships with supervisors, and openness of information during maintenance and fault-handling activities functions as a key human-factors element that influences the operational reliability of CNSD equipment. Effective communication and coordination are key factors in maintaining the safety and reliability of high-technology systems, since most errors in complex systems, including flight navigation systems, originate from failures in communication and coordination among personnel (Salas et al., 2015). Fatigue and workload are also recognized as human-factors elements that can reduce concentration, slow decision-making, and increase the risk of communication and coordination errors (Wickens et al., 2015; ICAO, 2016). Accordingly, Human Factors Theory provides the theoretical foundation for this study by explaining how the social work environment influences the operational reliability of CNSD equipment.

2.2 Social Work Environment

The social work environment refers to the overall condition of interpersonal relationships within a workplace, encompassing communication, cooperation, coworker



support, and the quality of subordinate–supervisor relationships. Robbins and Judge (2022) explain that a conducive social work environment increases mutual trust, strengthens motivation, and supports the smooth execution of technical tasks in high-risk organizations such as the aviation sector. According to the human factors theory advanced by Salas et al. (2015), effective communication and coordination are key factors in maintaining the safety and reliability of high-technology systems, since most errors in complex systems, including flight navigation systems, originate from failures in communication and coordination among personnel. Fatigue and workload are also recognized as human-factors elements that can reduce concentration, slow decision-making, and increase the risk of communication and coordination errors (Wickens et al., 2015; ICAO, 2016). In this study, the social work environment variable was developed into the dimensions of communication, team coordination, working relationships, openness of information, work systems, and working conditions (human factors), which were then translated into ten indicators used to construct the research instrument.

2.3 CNSD Equipment Operational Reliability

Reliability is the probability that equipment functions properly over a specific period according to defined operational standards. ICAO Annex 10 requires CNSD systems to meet a very high level of availability, generally at least 99%, because even a minor disturbance can cause flight delays, reduce air traffic capacity, and pose safety risks (ICAO, 2018). ICAO further explains, through its Performance-Based Navigation (PBN) Manual and the Manual on Testing of Radio Navigation Aids (Doc 8071), that the reliability of navigation systems must satisfy the service characteristics of accuracy, integrity, continuity, and availability (ICAO, 2016; ICAO, 2018). In addition, reliability-engineering concepts such as Mean Time Between Failure (MTBF) and Mean Time to Repair (MTTR) are used to assess equipment reliability quantitatively; a high MTBF and a low MTTR indicate a reliable and easily restored system (O'Connor & Kleyner, 2012; Lewis, 1996). In this study, the operational reliability of CNSD equipment was developed into the dimensions of availability, reliability, performance/accuracy, responsiveness, maintainability, compliance, and operational impact, translated into eight indicators.

2.4 Social Work Environment, CNSD Equipment Operational Reliability

Prior studies emphasize that communication and effective teamwork improve decision-making quality and reduce technical error in high-technology systems (Salas et al., 2015); that human error is a latent factor behind accidents in high-risk systems (Reason, 1990); and that the work environment and social relationships significantly affect the operational performance of aviation ground units (Fajriati & Noviyanty, 2024). Effective communication, sound coordination, and harmonious working relationships among technicians are theorized to enhance the effectiveness of maintenance and fault-handling activities, which in turn is reflected in higher equipment availability, continuity, integrity, and faster fault resolution. Based on the theoretical explanation and empirical findings, the hypothesis proposed in this study is as follows:

H1: The social work environment has a significant effect on the operational reliability of CNSD equipment at Soekarno-Hatta International Airport.

3. Methods

3.1 Research Design

This study employs a quantitative approach with an associative design to examine the effect of the social work environment (independent variable) on the operational reliability



of CNSD equipment (dependent variable) through inferential statistical analysis. The quantitative approach is considered appropriate because the study aims to empirically test the proposed hypothesis using statistical analysis of numerical data derived from questionnaire responses. The associative research design enables the examination of causal relationships between independent variable (Social Work Environment) and dependent variable (CNSD Equipment Operational Reliability). This study is descriptive and explanatory in nature, explaining the relationships between variables and the extent to which these variables influence each other. The type of data used is primary data obtained through a closed questionnaire, complemented by secondary data from maintenance reports, fault logs, standard operating procedures, and ICAO Annex 10 documents.

3.2 Population and Sample

The research was conducted at the CNSD Technical Unit of Perum LPPNPI (AirNav Indonesia) Jakarta Air Traffic Service Center (JATSC), located at Soekarno-Hatta International Airport, during April–May 2026. The population in this study consists of all air navigation technicians assigned to the CNSD Unit of JATSC, totaling 55 technicians. The sample was selected using probability sampling with the simple random sampling method, giving every member of the population an equal chance of being selected as a respondent, with the following criteria: (1) air navigation technicians assigned to the CNSD Unit of JATSC during the April–May 2026 period; (2) technicians who have direct involvement in operating, maintaining, and handling disturbances in CNSD equipment; (3) technicians who have completed the questionnaire in full; (4) technicians who are willing to participate as respondents; (5) technicians who are accessible through online questionnaire distribution; and (6) technicians with complete data for all research variables. Based on these criteria, the final sample includes 55 technicians, as presented in Table 1.

Table 1. Sample Determination

No	Criteria	Quantity
1	Air Navigation Technicians assigned to the CNSD Unit of JATSC	55
2	Questionnaires completed in full and used in the analysis	55
3	Total Research Respondents	55

Source: Processed data (2026)

3.3 Data Collection Techniques

This study uses primary data obtained through a closed questionnaire developed on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree) and distributed online via Google Forms, complemented by secondary data from equipment maintenance reports, fault logs, standard operating procedures, and ICAO Annex 10 documents. The data collection procedure involved several sequential steps: (1) questionnaire development based on the operational definitions of research variables and adaptation of validated measurement scales from previous studies; (2) content validity assessment through expert judgment to evaluate the clarity, relevance, and comprehensiveness of questionnaire items; (3) distribution of questionnaires online via Google Forms to air navigation technicians at the CNSD Technical Unit of JATSC; (4) collection and compilation of completed questionnaires; (5) data screening and cleaning to identify and remove incomplete or invalid responses; and (6) coding and tabulation of valid data for statistical analysis. The questionnaire measured ten indicators of the social work



environment (X1–X10), covering communication clarity, speed of fault-related information delivery, coordination during disturbances, coworker support, supervisory direction, openness of technical information, cross-shift teamwork, minimal miscommunication, and the effect of fatigue and shift patterns on communication and concentration; and eight indicators of CNSD equipment operational reliability (Y1–Y8), covering availability, disturbance frequency, technical performance, fault-detection speed, MTTR, reliability consistency, compliance with ICAO Annex 10, and operational impact on flight services. The data sources employed in this research are considered reliable as they represent official records from authorized institutions and established data providers.

3.4 Operational Definition of Variables

Table 2. Operational Definition and Measurement of Variables

Variable	Definition	Measurement	Scale	Source
CNSD Equipment Operational Reliability (Y)	The probability that CNSD equipment functions properly over a specific period according to defined operational standards	Availability, disturbance frequency, technical performance, fault-detection speed, MTTR, reliability consistency, compliance with ICAO Annex 10, and operational impact on flight services	Likert 1–5	ICAO (2018); O'Connor & Kleyner (2012); Lewis (1996)
Social Work Environment (X)	The overall condition of interpersonal relationships within a workplace, encompassing communication, cooperation, coworker support, and the quality of subordinate–supervisor relationships	Communication clarity, speed of fault-related information delivery, coordination during disturbances, coworker support, supervisory direction, openness of technical information, cross-shift teamwork, minimal miscommunication, and the effect of fatigue and shift patterns on communication and concentration	Likert 1–5	Robbins & Judge (2022); Salas et al. (2015); Wickens et al. (2015)

Source: Developed for this research (2026)

3.5 Data Analysis Techniques

Data analysis in this study was conducted using simple linear regression with the assistance of IBM SPSS Statistics. The analysis stages included descriptive statistics, validity and reliability tests, classical assumption tests, simple linear regression analysis, and hypothesis testing. Instrument validity was tested using Corrected Item-Total



Correlation, where an item was considered valid if the correlation value was greater than 0.30. Reliability was tested using Cronbach's Alpha, where a construct was considered reliable if the Cronbach's Alpha value was at least 0.70. Descriptive statistics were employed to describe the characteristics of the research data, including minimum, maximum, mean, and standard deviation for all variables examined in the study.

Prior to hypothesis testing, classical assumption tests were conducted to ensure that the regression model satisfied the required assumptions. The tests included the normality test using Kolmogorov-Smirnov and Shapiro-Wilk to examine whether residuals were normally distributed, where a probability value greater than 0.05 indicated a normal distribution, supported by a Normal Q-Q Plot in which residual points followed the diagonal reference line; and the homoscedasticity test using a scatterplot of ZPRED against ZRESID to examine whether residuals had constant variance, where points scattered randomly above and below zero with no discernible pattern indicated that the assumption of homoscedasticity was satisfied.

Simple linear regression analysis was conducted to examine the effect of the social work environment on CNSD equipment operational reliability. The regression model used in this study was formulated as:

$$Y = a + bX$$

Where:

Y = CNSD Equipment Operational Reliability

a = Constant

b = Regression coefficient

X = Social Work Environment

Hypothesis testing was conducted using several methods. The partial t-test was used to determine the partial effect of the social work environment on CNSD equipment operational reliability. The F-test was used to examine the fitness of the regression model. The coefficient of determination (R^2) was used to determine the proportion of variance in CNSD equipment operational reliability explained by the social work environment. All hypothesis tests were conducted at a significance level of 5% ($p < 0.05$).

4. Results and Discussion

4.1 Descriptive Statistics

Table 3. Descriptive Statistics of Research Variables

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Social Work Environment	55	24	40	33.49	3.284
CNSD Equipment Operational Reliability	55	26	40	34.84	2.851

Source: Processed data (2026)

Table 3 presents the descriptive statistics for all research variables. The data shows that the social work environment variable had a mean score of 33.49, close to its maximum possible score of 40, indicating that respondents generally rated the social work environment in the CNSD Technical Unit favorably. The CNSD equipment operational reliability variable had a mean score of 34.84, also close to its maximum, indicating that the operational reliability of the equipment was perceived positively. The standard deviations of both variables were relatively small compared with their means, indicating that respondents' answers were fairly homogeneous.



4.2 Validity and Reliability Test

Table 4. Validity Test Results of the Social Work Environment Variable (X)

Item	Corrected Item-Total Correlation	Description
X1	0.809	Valid
X2	0.523	Valid
X3	0.805	Valid
X4	0.631	Valid
X5	0.709	Valid
X6	0.777	Valid
X7	0.839	Valid
X8	0.757	Valid
X9	0.191	Invalid
X10	0.278	Invalid

Source: Processed data (2026)

Table 4 shows the validity test results for the social work environment variable. Eight items (X1–X8) had Corrected Item-Total Correlation values above 0.30 and were declared valid, while two items (X9 and X10, both related to fatigue and shift-pattern effects) had values below 0.30 and were excluded from further analysis. The invalid items indicate that, within this sample, technicians did not consistently perceive fatigue as part of the social work environment construct itself, even though fatigue remains a recognized human-factors concern in aviation operations.

Table 5. Validity Test Results of the CNSD Equipment Operational Reliability Variable (Y)

Item	Corrected Item-Total Correlation	Description
Y1	0.401	Valid
Y2	0.730	Valid
Y3	0.780	Valid
Y4	0.766	Valid
Y5	0.634	Valid
Y6	0.832	Valid
Y7	0.763	Valid
Y8	0.334	Valid

Source: Processed data (2026)

Table 5 shows the validity test results for the CNSD equipment operational reliability variable. All eight items (Y1–Y8) were valid, with values ranging from 0.334 (Y8) to 0.832 (Y6), indicating that all measurement items accurately measure the intended construct.

Table 6. Reliability Test Results

Variable	Cronbach's Alpha	N of Items	Description
Social Work Environment (X)	0.917	8	Reliable
CNSD Equipment Operational Reliability (Y)	0.885	8	Reliable

Source: Processed data (2026)

Table 6 shows the reliability test results. The social work environment variable produced a Cronbach's Alpha of 0.917 based on the eight valid items, and the CNSD equipment operational reliability variable produced a Cronbach's Alpha of 0.885, both



well above the 0.70 threshold. This indicates that both research instruments have a high level of internal consistency and are suitable for measuring the intended constructs.

4.3 Classical Assumption Tests

Table 7. Classical Assumption Test Results

Assumption Test	Indicator	Result	Criteria	Conclusion
Normality	Kolmogorov-Smirnov Sig.	0.200	> 0.05	Normal
	Shapiro-Wilk Sig.	0.966	> 0.05	Normal
Homoscedasticity	Scatterplot of ZPRED vs ZRESID	Random distribution of points above and below zero with no discernible pattern	No clear pattern	No Homoscedasticity

Source: Processed data (2026)

Table 7 presents the classical assumption test results. The normality test produced a Kolmogorov-Smirnov significance value of 0.200 and a Shapiro-Wilk significance value of 0.966, both greater than 0.05, indicating that the regression residuals were normally distributed; this was supported by a Normal Q-Q Plot in which residual points followed the diagonal reference line. The homoscedasticity test, examined through a scatterplot of ZPRED against ZRESID, showed points scattered randomly above and below zero with no discernible pattern, indicating that the assumption of homoscedasticity was satisfied and the regression model was appropriate for further analysis. Overall, the results indicate that the regression model satisfies the classical assumptions and is therefore appropriate for further analysis.

4.4 Hypothesis Testing

Table 8. Simple Linear Regression Results

Variable	Coefficient (B)	t-value	Sig.	Result
Constant	14.378			
Social Work Environment (X)	0.611	7.496	0.000	H1 Accepted
F-value	56.189		0.000	Model Fit
R Square	0.515			

Source: Processed data (2026)

Based on the simple linear regression results presented in Table 8, the regression equation of this study can be formulated as follows:

$$Y = 14.378 + 0.611X$$

Based on the regression results presented in Table 8, the analysis was conducted using simple linear regression, which was selected as the most appropriate estimation model because the study examines the effect of one independent variable on one dependent variable. The results indicate that the social work environment has a positive and significant effect on CNSD equipment operational reliability, with a regression coefficient of 0.611 and a significance value of 0.000. The constant of 14.378 indicates the predicted level of CNSD equipment operational reliability when the social work environment score is zero, while the regression coefficient of 0.611 indicates that every



one-unit increase in the social work environment score raises the CNSD equipment operational reliability score by 0.611 units, reflecting a positive relationship between the two variables. The partial t-test produced a t-value of 7.496 with a significance of 0.000 ($p < 0.05$), so H_0 was rejected and H_1 was accepted, meaning the social work environment has a positive and significant effect on the operational reliability of CNSD equipment. The F-test produced an F-value of 56.189 with a significance of 0.000 ($p < 0.05$), indicating that the regression model was fit to explain the relationship between the two variables. The coefficient of determination (R^2) was 0.515, meaning the social work environment explains 51.5% of the variation in CNSD equipment operational reliability, while the remaining 48.5% is explained by other factors outside the model, such as technician competence, work experience, technical training, equipment condition and age, spare-parts availability, and maintenance systems.

4.5 Discussion

4.5.1 The Effect of Social Work Environment on CNSD Equipment Operational Reliability

The results show that the social work environment of air navigation technicians has a positive and significant effect on the operational reliability of CNSD equipment at Soekarno-Hatta International Airport ($t = 7.496$; $p = 0.000$), indicating that a more conducive social work environment leads to higher equipment operational reliability. This finding is consistent with the human factors perspective advanced by Salas et al. (2015) and the organizational behavior theory of Robbins and Judge (2022), both of which emphasize that effective communication, coordination, and interpersonal relationships strengthen performance and reduce error in complex, high-risk systems. The result is also consistent with Fajriati and Noviyanty (2024), who found a positive relationship between the work environment and operational performance in an aviation ground unit at the same airport. The valid indicators of the social work environment communication clarity among technicians, speed of fault-information delivery, coordination during disturbances, coworker support, supervisory direction, openness of technical information, cross-shift teamwork, and minimal miscommunication describe the practical channels through which a favorable social work environment translates into faster fault detection, troubleshooting, escalation, and corrective maintenance, thereby supporting equipment availability and shortening MTTR. Notably, the two items concerning fatigue and shift-pattern effects on concentration (X9, X10) were found invalid, suggesting that, within this sample, technicians did not consistently perceive fatigue as part of the social work environment construct itself, even though fatigue remains a recognized human-factors concern in aviation operations (Wickens et al., 2015; ICAO, 2016); this indicates fatigue may be better treated as a separate variable in future models rather than as a dimension of the social work environment.

4.5.2 The Role of Social Work Environment Dimensions in Equipment Reliability

The findings further indicate that the social work environment, with an R^2 of 51.5%, is a substantial but not exclusive determinant of CNSD equipment operational reliability. The remaining 48.5% of variance is plausibly attributable to technical and organizational factors not covered in this model, such as technician competence and experience, training frequency, equipment age and condition, spare-parts availability, and maintenance-management systems. This suggests that improving reliability requires a combined strategy addressing both the social work environment and these technical-organizational



factors. From the perspective of Human Factors Theory, the social work environment operates as a key human-factors element that influences the effectiveness of maintenance and fault-handling activities, which in turn is reflected in higher equipment availability, continuity, integrity, and faster fault resolution (Salas et al., 2015). Accordingly, strengthening technical communication, team coordination, coworker support, openness of information, and supervisory support is recommended for the CNSD Unit to further enhance equipment reliability and support safe, orderly, and continuous flight navigation services.

5. Conclusion

This study aimed to examine the effect of the social work environment of air navigation technicians on the operational reliability of CNSD equipment at Soekarno-Hatta International Airport. Using a quantitative approach with an associative design on 55 air navigation technicians of the CNSD Technical Unit at Perum LPPNPI (AirNav Indonesia) Jakarta Air Traffic Service Center selected through simple random sampling, the study successfully tested the proposed hypothesis through simple linear regression analysis.

The results indicate that the social work environment has a positive and significant effect on the operational reliability of CNSD equipment, with a regression coefficient of 0.611 and a significance value of 0.000, indicating that H1 is accepted. The regression equation $Y = 14.378 + 0.611X$ indicates a positive relationship, confirmed by a significant partial t-test ($t = 7.496$; $\text{sig.} = 0.000$) and a fit regression model ($F = 56.189$; $\text{sig.} = 0.000$). A more conducive social work environment leads to higher equipment operational reliability, as effective communication, coordination, and interpersonal relationships strengthen performance and reduce error in complex, high-risk systems. This finding is consistent with the human factors perspective advanced by Salas et al. (2015) and the organizational behavior theory of Robbins and Judge (2022), both of which emphasize that effective communication, coordination, and interpersonal relationships strengthen performance and reduce error in complex, high-risk systems. This result is also consistent with Fajriati and Noviyanty (2024), who found a positive relationship between the work environment and operational performance in an aviation ground unit at the same airport. The social work environment explains 51.5% of the variation in CNSD equipment operational reliability ($R^2 = 0.515$), while the remaining 48.5% is explained by other factors outside this study, such as technician competence, work experience, technical training, equipment condition and age, spare-parts availability, and maintenance systems. Notably, the two items concerning fatigue and shift-pattern effects on concentration (X9, X10) were found invalid, suggesting that, within this sample, technicians did not consistently perceive fatigue as part of the social work environment construct itself, even though fatigue remains a recognized human-factors concern in aviation operations.

The theoretical implications of this study extend the application of Human Factors Theory and Organizational Behavior Theory to the context of CNSD equipment operational reliability in Indonesia. The finding that the social work environment significantly influences equipment operational reliability supports Human Factors Theory's emphasis on the role of communication, coordination, and teamwork in maintaining the safety and reliability of high-technology systems (Salas et al., 2015). The finding that the social work environment explains 51.5% of the variation in equipment operational reliability supports Organizational Behavior Theory's emphasis on the role of interpersonal relationships and working conditions in shaping performance and reducing



error in complex, high-risk systems (Robbins & Judge, 2022). This study also contributes to the limited empirical evidence on the determinants of CNSD equipment operational reliability, providing insights into how the social work environment influences equipment reliability in aviation navigation services.

Based on these findings, several recommendations can be proposed. The CNSD Unit should strengthen technical communication, team coordination, coworker support, openness of information, and supervisory support to further enhance equipment reliability and support safe, orderly, and continuous flight navigation services. Air navigation technicians should maintain and enhance their communication and coordination practices to ensure that fault-handling activities are conducted effectively and efficiently. Unit managers should consider the social work environment as an important factor in maintaining equipment reliability and should develop strategies to strengthen interpersonal relationships and working conditions within the unit. Aviation regulators should continue to strengthen oversight of human-factors practices in aviation navigation services to maintain flight safety and service continuity.

This study has several limitations that should be acknowledged. First, the study focuses only on the CNSD Technical Unit at Soekarno-Hatta International Airport, which may limit the generalizability of the findings to other airports or navigation service units. Second, the study uses a quantitative approach with simple linear regression, which limits the ability to capture the complexity of human-factors determinants of equipment reliability. Third, the study relies on self-reported data from respondents, which may be subject to social desirability bias and common method bias. Fourth, the model's explanatory power is moderate, with an R-squared value of 0.515, indicating that other factors not included in the model may still influence equipment operational reliability. Fifth, the study examines only the social work environment as a determinant of equipment operational reliability, without considering other potential determinants such as technician competence, training, workload, maintenance systems, and equipment age.

For future research, it is recommended to expand the scope of study by involving other airports or navigation service units to improve the generalizability of the findings. Future studies may also incorporate additional variables, such as technician competence, training, workload, maintenance systems, and equipment age, to provide a more comprehensive understanding of the factors affecting CNSD equipment operational reliability. Additionally, qualitative or mixed-method approaches may be employed to gain deeper insights into the challenges and effectiveness of human-factors practices in aviation navigation services. Researchers should also employ longitudinal designs to examine how equipment operational reliability evolves over time as organizational conditions and human-factors practices develop.

In conclusion, this study contributes to the growing body of literature on human factors and equipment reliability by providing empirical evidence on the determinants of CNSD equipment operational reliability at Soekarno-Hatta International Airport. The findings suggest that the social work environment significantly influences CNSD equipment operational reliability, explaining 51.5% of the variation in equipment reliability. As Indonesia continues to strengthen its aviation navigation services and human-factors practices, understanding these factors becomes increasingly important for developing effective strategies to enhance equipment reliability, strengthen flight safety, and support safe, orderly, and continuous flight navigation services.



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