Fatigue, Stress, and Job Satisfaction in the Air Traffic Controller (ATC) Work

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A R T I C L E I N F O

A B S T R A C T

This study explores the relationship between fatigue, stress, and job satisfaction among Air Traffic Controllers (ATCs). ATCs often experience physical and mental fatigue due to irregular work schedules, frequent shift changes, and high workload. Fatigue is defined as a state of exhaustion that affects alertness and decision-making abilities, increasing the risk of errors. Factors such as lack of sleep, time pressure, and the need to coordinate with multiple parties exacerbate stress. The research also shows that job satisfaction, which is crucial for psychological well-being, is influenced by levels of fatigue and stress. Low job satisfaction leads to burnout and reduced motivation, negatively impacting air traffic management. However, factors such as adequate rest, a supportive work environment, and fair compensation enhance job satisfaction. A quantitative research method was used, employing tools like the Fatigue Assessment Scale (FAS), Samn-Perelli 7-Point Scale, and Karolinska Sleepiness Scale. The results indicate that workload and stress are the main contributors to fatigue, with stress peaking during heavy air traffic periods. ATCs with higher job satisfaction demonstrated better stress-coping mechanisms. Recommendations include fatigue risk management programs, improved shift planning, adequate rest facilities, and psychological support. This study provides insights into the importance of mitigating fatigue and stress to enhance job satisfaction and operational safety.

INTRODUCTION

The job of Air Traffic Controller (ATC) is one of the most important professions in the aviation industry. The main task of ATC is to regulate air traffic to ensure flight safety. They are responsible for monitoring aircraft movements, giving instructions to pilots, and coordinating flights in a specific airspace. As a key role in flight safety, ATC work requires a high level of concentration and decision-making.

However, working as an ATC also carries significant risks related to fatigue and stress. High levels of air traffic, constant time pressure, and the need to make quick decisions in often very complex situations can lead to high levels of fatigue and stress in ATCs.

ATCs often operate in a work environment that requires high levels of concentration and constant monitoring of aircraft movements. Heavy air traffic, frequent shift changes, and constant time pressure can cause physical and mental fatigue in ATCs. This fatigue can impair their ability to make quick and accurate decisions, and increase the risk of errors that could impact flight safety.

Fatigue, or tiredness, is a physiological and psychological condition involving decreased energy, physical exhaustion, and mental exhaustion. It can be caused by a variety of factors, such as excessive physical activity, lack of sleep, stress, or prolonged mental pressure. The following is an understanding of fatigue according to several experts:

1. National Safety Council (NSC)
   The NSC defines fatigue as "physical or mental exhaustion that reduces alertness and performance, leading to an increased risk of errors and accidents."
2. International Civil Aviation Organization (ICAO)
   ICAO describes fatigue as "an adverse physical and mental state caused by lack of sleep, overwork, or sustained mental stress".
3. American Psychological Association (APA)
   According to the APA, fatigue is "a state of inability to maintain optimal levels of alertness and performance, often accompanied by decreased physical and mental energy."
4. National Institute for Occupational Safety and Health (NIOSH)
   NIOSH states that fatigue is "a state that occurs when the body and mind are unable to function at optimal levels due to lack of adequate rest or quality sleep."
5. American Academy of Sleep Medicine (AASM)
   AASM defines fatigue as "excessive physical and mental exhaustion that may interfere with a person's normal functioning, alertness, and performance."

In general, fatigue is a complex phenomenon that can have a significant impact on a person's well-being and performance. It can affect various aspects of life, including work, safety, and overall health. Therefore, fatigue management is important in an effort to maintain a balance between optimal performance and individual well-being.

LITERATURE RIVIEW

In addition to fatigue, ATCs also face high levels of stress in their jobs. Situations that are often complex and require quick decision-making, interaction with various parties, and great responsibility for flight safety can cause high levels of stress in ATCs. Excessive stress can have a negative impact on their mental and physical well-being, as well as their performance in carrying out daily tasks.

Stress is a physiological, emotional, and mental response to demands or pressures that a person encounters. The view of stress has evolved over time and many experts from various fields have contributed to understanding this phenomenon. Here are the definitions and understandings of stress according to several experts:

1. Hans Selye
    As one of the leading figures in stress research, Selye defined stress as "the reaction of the body to any demand or demand made upon it."
2. Richard S. Lazarus and Susan Folkman
    In their cognitive stress theory, Lazarus and Folkman describe stress as "the process by which individuals evaluate and cope with situations that they perceive as threatening or exceeding their available resources."
3. American Psychological Association (APA)
    According to the APA, stress is "a physiological and mental reaction to demands that exceed the individual's capacity to respond adequately."
4. Robert M. Sapolsky
    Sapolsky, a biologist, describes stress as "the body's response to physical or psychological pressures that are perceived as real or imagined threats to the individual's well-being."
5. Richard Boyatzis
    Boyatzis states that stress is "an imbalance between the demands placed by the environment and the individual's resources to meet those demands".
6. Walter Cannon
    Cannon introduced the term "fight or flight" to describe the body's response to a stressor, where the body is prepared to fight or flee from a perceived threat.

It can be concluded that stress is a complex phenomenon involving interactions between physical, emotional, and cognitive factors. Responses to stress can vary from individual to individual, and can have a significant impact on a person's physical and mental well-being. Therefore, it is important to understand stress and effective strategies to manage it in order to maintain an individual's balance and well-being.

Job satisfaction is an important aspect in maintaining the psychological well-being and productivity of workers, including ATCs. High job satisfaction has been shown to be associated with better performance, higher employee retention, and a more positive work environment. However, high levels of burnout and stress can reduce ATCs' job satisfaction levels, threaten their overall well-being, and potentially reduce the quality of service they provide.

Job satisfaction, or job satisfaction, refers to an individual's subjective evaluation of his or her job. This concept has been the focus of research in the fields of industrial and organizational psychology and human resource management. Various experts have provided definitions and understandings of job satisfaction. Here are some opinions from experts regarding job satisfaction:

1. Edwin A. Locke

   Locke is one of the main figures in research on job satisfaction. According to him, job satisfaction is "an individual's perception of the match between the expected results of the job and the results received".

2. Frederick Herzberg

   Herzberg developed the Motivation-Hygiene Theory that distinguishes between motivational factors and hygiene factors in the work environment. According to him, job satisfaction is mainly influenced by motivational factors such as achievement, recognition, and responsibility.

3. Hackman and Oldham

   They developed the Job Characteristics Model which highlights the importance of job satisfaction through job design that provides task variety, autonomy, and feedback.

4. David A. Brayfield and Charles C. Rothe

   Brayfield and Rothe define job satisfaction as "individuals' reactions to the characteristics of their jobs, especially those aspects that are pleasant or unpleasant".

5. Paul E. Spector

   Spector developed the Multidimensional Job Satisfaction Model to measure job satisfaction across multiple dimensions, including satisfaction with pay, satisfaction with coworkers, and satisfaction with organizational policies.

6. Victor Vroom

   Vroom proposed that job satisfaction can be influenced by equity theory, in which individuals evaluate the level of fairness in the distribution of the rewards of their work.

The understanding of job satisfaction has evolved over time, and most of the proposed theories and models aim to explain the factors that influence job satisfaction and its impact on individual performance, employee retention, and overall organizational well-being.

Not only the discussion on the terms or definitions along with the impacts and symptoms, but also important to understand how factors such as fatigue and stress can affect the job satisfaction of ATCs. Job satisfaction is an important concept in industrial and organizational psychology, which refers to an individual's subjective evaluation of their job. High job satisfaction has been shown to be associated with better performance, better employee retention, and higher levels of customer satisfaction.

In the context of ATC work, high levels of job satisfaction can contribute to the reliability of the air traffic control system as well as the psychological and physical well-being of ATCs themselves. Therefore, it is important to explore the

relationship between burnout, stress, and job satisfaction in the context of ATC work.

Research purposes

The main objective of this study is to investigate the relationship between levels of fatigue, stress, and job satisfaction among Air Traffic Controllers. This study aims to:

1. Identifying factors that cause fatigue in ATCs.
2. Conducting fatigue assessment tests on ATCs.
3. Identifying factors to avoid fatigue in ATCs.
4. Identifying signs of fatigue in ATCs.
5. Analyzing sleep scales in ATCs.
6. Analyzing the factors that cause stress in general and specifically in ATCs.
7. Assess the level of job satisfaction of ATCs and the factors that influence it and create job satisfaction.
8. To find the relationship between the levels of fatigue, stress, and job satisfaction of ATCs.
9. Make recommendations to reduce fatigue and stress levels and increase job satisfaction of ATCs.

METODOLOGY

This study will use a quantitative approach to collect and analyze data. A survey instrument will be used to collect data from ATCs working in various work environments and geographic locations. The survey will include questions designed to measure respondents' levels of burnout, stress levels, and job satisfaction.

Some research methods refer to several references that are interrelated with each other. Some references for conducting surveys and the methods used include:

1. NovoPsych on the Fatigue Assessment Scale (FAS);
2. The Samn-Perelli 7-Point Scale;
3. Karolinska Sleepiness Scale (KSS);
4. Karolinska Sleepiness Questionnaire;
5. Beehr (1995) on Job Stress;
6. Hackman and Oldham (1975) on Job Satisfaction;
7. Giovanni Costa (2000) Working and Health Conditions of Italian Air Traffic Controllers, International Journal of Occupational Safety and Ergonomics.

In addition, data on work performance and mental well-being indicators will also be collected, both through official performance records and valid psychometric instruments. Statistical analyses, such as regression analysis and correlation tests, will be used to explore the relationships between the variables studied.

Significance of the Research

This study is expected to provide a better understanding of the factors that influence fatigue, stress, and job satisfaction of Air Traffic Controllers. The findings of this study can provide insight to related parties, including the

government, aviation regulators, and airline management, especially AirNav Indonesia, to identify and implement effective strategies in managing the risk of fatigue and stress and increasing job satisfaction of ATCs.

Increasing awareness of the importance of ATCs' psychological well-being can also help in designing policies and programs aimed at promoting a healthy and sustainable work environment. Thus, this study has the potential to make a significant contribution to aviation safety as well as the well-being and productivity of Air Traffic Controllers.

Research Extension

Although there have been several studies examining these factors separately, there is still a need to combine the analysis of fatigue, stress, and job satisfaction of ATCs into one comprehensive research framework. Thus, this study aims to fill this knowledge gap by exploring in depth the relationship between fatigue, stress, and job satisfaction in ATCs, as well as their implications for aviation safety and the well-being of these workers.

RESEARCH RESULT

This study aims to investigate the relationship between fatigue, stress, and job satisfaction levels in Air Traffic Controllers (ATC). Based on data analysis from various parameters investigated, the following are the research findings: Based on the research results, the factors that cause fatigue which can be ranked according to priority are as follows:
1. Job Stress
2. Physical, Vision & Mental
3. Schedule and Work Shift Planning
4. Working hours
5. Working Environment Conditions
6. Workload
7. Geographic Location
8. Irregular Operations
9. Interaction and Communication
10. Experience Level
11. HR Settings and Policies
12. Health condition
13. Family Problem

Things that are signs of Fatigue in ATC personnel that can be ranked according to priority are as follows:
1. Uncharacteristic behavior such as reduced motivation, irritability, or moodiness.
2. Pilot call or readback is missing, may have to ask pilot or partner to repeat information.
3. Forgetting routine tasks (such as course marking or moving the aircraft to the next sector).
4. Starting to fall behind in planning, perhaps getting caught out or surprised by something you would normally anticipate at the right time.

5. Didn't see the plane when planning from radar due to narrowed attention.
6. Confused about the steps of a plan, may have to change the plan.
7. There are no warning indications.
8. Disruption in teamwork or leadership – not communicating well with colleagues or taking longer to tell others what to do.
9. It becomes harder to concentrate on the ATC situation and more easily distracted.
10. Irritability – pronounced irritability and moodiness often triggered by routine tasks or other trivial stimuli.
11. Yawning and generally looking tired, eyes closed or even unable to stay awake.
12. Lack of communication or interaction – becoming more withdrawn and withdrawn.
13. Ask to take on a quieter or easier role.
14. Uncharacteristic task performance, such as inability to manage typical workload levels, increased errors.

Factors that can prevent fatigue in ATC personnel which can be ranked according to priority are as follows:
1. Job satisfaction
2. Sleep & Rest
3. Physical, Visual & Mental Fitness
4. Drugs & Alcohol
5. Medical Conditions
6. Wellbeing & Coping
7. Holiday
8. Arranging Other/Side Jobs
9. Fatigue Self-Report (Just Culture) using The Samn-Perelli 7-Point Scale Method and/or Karolinska Sleepiness Scale
10. Hobbies
11. Rest room for ATC

Fatigue
1. Most ATCs experience varying degrees of fatigue, with some experiencing fatigue regularly or even frequently.
2. Factors that cause fatigue in ATCs include high work pressure, irregular work schedules, uncomfortable work environments, and prolonged mental stress.
3. To avoid fatigue, ATCs are advised to develop lifestyle habits that take work shifts into account, ensure adequate and quality rest, maintain physical fitness, avoid consuming drugs and alcohol, and manage rest time well.

Furthermore, the results regarding work stress can show that the factors that can cause work stress in general which can be ranked according to priority include:

1. Work Load Pressure
2. Performance Pressure
3. Role Ambiguity
4. Home Work Interface
5. Relationship With Others
6. Family Problem

Factors that can cause work stress in ATC personnel that can be ranked according to priority include:
1. Financial difficulties
2. Peak level of traffic load
3. Noise and distractions in the control room
4. Layout and Reliability of equipment
5. Visual discomfort
6. Total duration of a duty period
7. irregular/unexpected traffic (VIP, Military etc)
8. Shift pattern
9. Adequacy of rest facilities
10. Travel to work
11. Weather
12. Adequacy of canteen facilities
13. Public comments on ATC
14. Relations with management, colleagues, unions
15. Planning work and holiday periods
16. Family/self problems

Stres
1. ATCs face significant levels of stress, particularly related to performance pressure, role ambiguity, high workloads, and relationships with coworkers.
2. Specific factors that cause stress in ATC work include peak air traffic volumes, disturbances and noise in the control room, visual discomfort, and weather uncertainty.
3. Managers and supervisors need to watch for signs of burnout and stress in ATCs, and provide the necessary support and assistance to reduce their negative impacts.

Then the results regarding job satisfaction can be shown that the factors that can cause work stress in general which can be ranked according to priority include:
1. Pay
2. Job Pleasure
3. Job Security
4. Co-Worker
5. Supervision
6. Personal Growth & Development

7. Working environment (safe building, canteen facilities, rest room)

The results related to things that can create job satisfaction for ATC personnel that can be ranked according to priority include:
1. Salary & Finance
2. Aviation Operational Safety
3. Facility Development & Improvement
4. Proportional Guiding Hours and Workload
5. Colleagues who help & support each other
6. Comfortable Working Environment Conditions
7. There are no complaints from stakeholders
8. Good relationship
9. Future & Holidays for sure
10. Visual Comfort

Job Satisfaction/Job Satisfaction
1. Despite facing significant challenges, most ATCs report relatively high levels of job satisfaction.
2. Factors that create job satisfaction in ATC include adequate salary, flight operational safety, adequate work facilities, support from coworkers, a comfortable work environment, and guaranteed holiday availability.
3. It is important for organizations to pay attention to these factors in order to maintain high levels of job satisfaction and safeguard the mental and physical well-being of ATCs.

The following are the results of a survey on fatigue, stress and ATC satisfaction at work using the fatigue assessment test method.
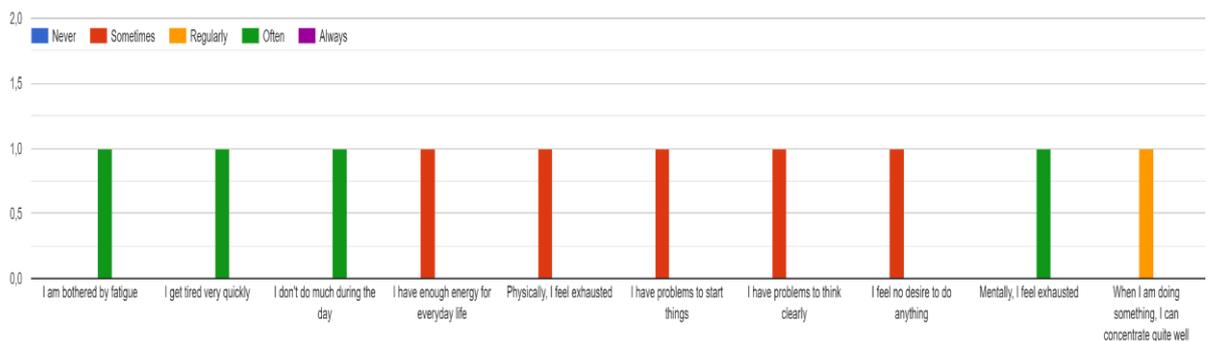

Figure 1. The Results of a Survey on Fatigue, Stress and Atc Satisfaction at Work using the Fatigue Assessment Test Method

The following are the results of a survey on fatigue, stress and ATC satisfaction at work using the Karolinska Methods.
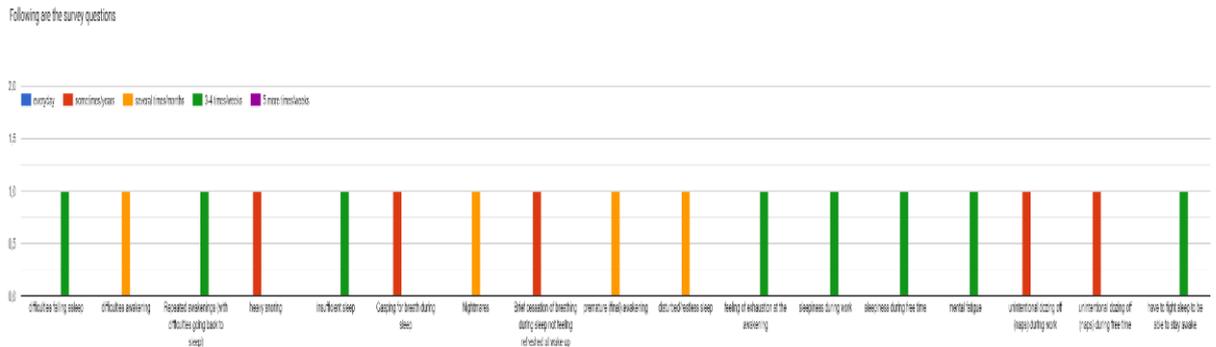

Figure 2. The Results of a Survey on Fatigue, Stress and Atc Satisfaction at Work using the Karolinska Method

Based on these findings, it is recommended that relevant parties, including aviation management and regulators, take steps to manage the risks of fatigue and stress in ATCs. This may include implementing effective fatigue management programs, improving work facilities, and providing psychological and social support to workers. This is expected to improve flight safety, ATC welfare, and overall job satisfaction.

Next, the results of the next study used the Karolinska Sleepiness Survey to evaluate sleep patterns and sleepiness levels in Air Traffic Controllers (ATC). The following are the results of the study based on the parameters investigated:

Difficulty Sleeping
1. Most ATCs reported having difficulty sleeping sometimes or several times a week.
2. Factors contributing to sleep difficulties include difficulty falling asleep, difficulty waking up, and multiple awakenings with difficulty returning to sleep.
3. Some ATCs also reported having nightmares, waking up feeling exhausted, and experiencing restless sleep.

Sleep Quality
1. Most respondents reported that they did not feel refreshed when they woke up and experienced mental fatigue.
2. Nearly all respondents stated that they experienced drowsiness while working, with some reporting difficulty staying awake while working.

Sleep Pattern
1. ATC sleep patterns tend to be irregular, with most respondents reporting varying bedtimes and wake times on weekdays and holidays.
2. Most ATCs reported that they needed only a short time to fall asleep, but some also reported difficulty in initiating sleep.

Sleep Needs and Sleep Habits
1. Most ATCs reported that they did not get enough sleep, with the majority of respondents stating that they did not get good enough sleep.

2. Many respondents also reported that they often felt tired and that sleep was a problem for them.

Napping Habit

1. The majority of ATCs reported that they sometimes or often take naps during work and leisure time.
2. Some respondents also reported that they had to fight sleepiness to stay awake during work hours.

Sleep Habits Type

1. Most respondents stated that they were not morning or night owls, but the majority showed a tendency to sleep late.
2. Several respondents indicated that they needed more sleep than they were getting.

So based on the following findings, it is recommended that ATC organizations and management pay attention to the sleep patterns and sleep well-being of their workers. Efforts should be made to improve sleep quality and ensure that ATCs get enough rest to maintain their alertness and optimal performance during their duties in managing air traffic.

CONCLUSIONS AND RECOMMENDATIONS

The study explores the intricate relationship between fatigue, stress, and job satisfaction, key elements that significantly impact ATC performance and well-being. The role of an ATC is demanding, requiring high levels of concentration, quick decision-making, and managing complex situations involving aircraft and airspace. These pressures can lead to significant levels of fatigue and stress, which, if unmanaged, may result in impaired decision-making and potentially jeopardize flight safety.

Fatigue is a critical issue for ATCs, as the job often involves irregular work schedules, frequent shift changes, and high mental and physical demands. Fatigue, as defined by several organizations like the National Safety Council (NSC), the International Civil Aviation Organization (ICAO), and the American Psychological Association (APA), results from insufficient rest or prolonged mental and physical exertion. It can lead to decreased alertness, slower reaction times, and an increased risk of errors. The study highlights several signs of fatigue in ATCs, including irritability, reduced motivation, and errors in communication with pilots. To mitigate fatigue, it is crucial for ATCs to have adequate rest, maintain physical fitness, and avoid excessive reliance on substances like alcohol or medication.

Stress is another significant factor, as ATCs operate in high-stakes environments with constant time pressures and the need for quick, accurate decisions. Stress in ATCs is caused by factors such as workload pressure, role ambiguity, and performance demands. Situations like irregular air traffic, peak workloads, and environmental factors (e.g., noise and layout of control rooms) also contribute to high stress levels. Stress can have negative physical and psychological effects, leading to burnout, reduced job satisfaction, and decreased performance. The study draws from the work of stress experts like Hans Selye and Richard Lazarus to emphasize that stress responses are highly individual

and can have broad implications for both personal well-being and professional performance.

Job satisfaction plays a vital role in an ATC's psychological well-being and work performance. High job satisfaction is associated with better performance, employee retention, and a positive work environment. Conversely, high levels of stress and fatigue can reduce job satisfaction. The research explores job satisfaction through models like Herzberg's Motivation-Hygiene Theory and Hackman and Oldham's Job Characteristics Model, which emphasize the importance of factors like autonomy, task variety, and feedback in promoting job satisfaction. In the ATC context, job satisfaction is influenced by factors such as adequate salary, safe working conditions, support from coworkers, and a manageable workload.

The research aims to deepen understanding of the relationship between fatigue, stress, and job satisfaction in ATCs by identifying causes, symptoms, and potential interventions. Recommendations from the study include implementing better fatigue management strategies, such as more judicious scheduling, providing psychological and social support for stress management, and promoting sleep health to enhance overall job performance and well-being. Ensuring that ATCs have access to appropriate rest facilities and maintaining an open dialogue between management and controllers is also crucial for preventing burnout and improving job satisfaction.

This comprehensive study has significant implications for aviation safety, as managing fatigue and stress while enhancing job satisfaction directly impacts the performance and reliability of ATCs.

Fatigue and Stress Risk Management
1. ATC organizations need to implement effective fatigue and stress risk management programs. This may include more judicious shift scheduling, work hour restrictions, and adequate rest between shifts for physical and mental recovery.
2. Psychological and social support is also important in helping ATCs cope with the stress associated with their duties. Counseling programs and stress management training can help reduce the negative impact of stress on their well-being and performance.

Sleep Health Promotion
1. It is important for organizations to pay attention to the sleep patterns of ATCs. Sleep health promotion programs, including education about the need for adequate sleep and strategies to improve sleep quality, can help reduce fatigue and increase alertness during work hours.
2. Facilities that support comfortable sleep, such as quiet and dark break rooms, can also help ATCs get quality rest between shifts.

Routine Assessment and Monitoring of Well-Being
1. Organizations need to conduct regular assessments of the psychological and physical well-being of ATCs. This can be done through mental health

surveys, performance evaluations, and open dialogue between management and workers.

2. Monitoring for signs of fatigue and stress that could potentially be detrimental to the well-being and performance of ATCs should also be carried out regularly.

Facility Improvement and Organizational Support
1. ATC organizations need to continue to improve the facilities and support available to their workers. This includes providing access to health and wellness programs, sports facilities, and opportunities for recreation and relaxation outside of work hours.
2. Management also needs to listen to the input and needs of ATCs and provide quick and appropriate responses to changes in the work environment and working conditions.

By implementing these steps, it is hoped that the ATC organization can improve the welfare and performance of Air Traffic Controllers, as well as ensure optimal flight safety for all parties involved.

ADVANCED RESEARCH
In writing this article the researcher realizes that there are still many shortcomings in terms of language, writing, and form of presentation considering the limited knowledge and abilities of the researchers themselves. Therefore, for the perfection of the article, the researcher expects constructive criticism and suggestions from various parties.

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