Human-Centered Approach of Philippine Air Traffic Control Operators (ATCOS): A Comprehensive Cognitive Evaluation Towards Decision Making and Resiliency

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Abstract— **The exponential growth of the Philippine aviation industry cultivates the upsurge of air traffic volume and flight delays that imposes great pressure on Air Traffic Control Operators (ATCOs) to achieve efficient and safe Air Traffic Management (ATM). This paper explores an in-depth cognitive analysis of Philippine Air Traffic Control Operators (ATCOs) to produce a comprehensive approach toward decision-making and resiliency. The study specifically targeted ATCOs registered under the Civil Aviation Authority of the Philippines (CAAP), encompassing different ratings within the profession- 20 participants were selected through a parametric convenience sampling technique tailored to the practical constraints of active ATCOs. The investigation integrated principles from aviation psychology, incorporating cognitive testing within a controlled setting. The researchers administered psychological assessments; Connor-Davidson Resilience Scale, Raven's Progressive Matrices, and Multi-domain Decisiveness Test, supervised by a registered psychometrician. The qualitative phase involved in-depth interviews with three ATCOs to further deepen the findings. Contrary to expectations, no significant differences in cognitive state and resilience were discerned between ATCOs with 0-9 and 10-20 years of experience. However, a significant difference is seen in decision-making indicating superior scores among those with a decade or more of service. Moreover, psychological variables influence resilience and decision-making, including cognitive and attentional decline, error recovery, situational awareness, and stress. Recommendations proposed by researchers in the case of replication studies as follows; investigations into gender and rating-specific, geographic locations and procedures influenced by culture that may influence the outcome of the study.**

***Index Terms*—ATCO, Attentional decline, Cognitive decline, Decision-making, Resiliency, Situational awareness, Stress.**

1. Introduction

After COVID-19 tremendously immobilized the aviation industry, recovery gradually began to manifest. In turn, the rapid rate of post-pandemic growth became the catalyst for researchers. The aim is to continuously establish and rectify previous systems to ensure that the approaches imposed are best suited to propel the industry forward. The upsurge in air traffic volume and numerous flight delays impose great pressure on Air Traffic Control Operators (ATCOs) to achieve efficient and safe Air Traffic Management (ATM). Hence, ATCOs applicants undergo an intensive screening procedure to ensure minimal human errors, outstanding skills, and psychophysiological resilient operators in the long run.

The very nature of the aviation industry is built on the symbiosis of technological advancement and humans. The aim is to maximize the use of technology, especially intelligent automation, and automated systems (Li et al., 2021). In addition to this, Di Flumeri et al. (2019) discussed that the integration of automation in the aviation industry is predicted to be an essential component in the future for efficient operations in ATC and ATM. However, reliance on it led to doubtful speculations based on its current advancement level. Hence, the system design should be human-centered to reduce risk and ensure reliability (Jordan, 2018, Li, 2018 as cited by Shneiderman 2020).

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The researchers acknowledged that it is necessary to understand previous lapses in psychological factors that contribute to stress, competency, decision-making, committing, and coping with error.

A significant factor that influences the selection of ATCOs is dependent on the degree of accuracy and quality of work that thrives amidst complexity (Pagnotta et al. 2022). The major role of ATCOs is to secure successful, and systematic management of air traffic (Suárez et al., 2022). The forefront duty is to resolve operational conflicts on the approach route and implement passenger safety above all (Ng et al., 2017 &, Dasari et al. 2019). Vlašic et al. (2022) suggested that ideal ATCOs should be founded on the ability of an organism to adapt effectively referred to as Genetic Algorithms (GA). Parameters of selection are reliant on the chromosomal representation, fitness metrics, and biologically inspired operators. However, Wang and Sobey (2019) argued that due to the great diversity of traits, methods of analysis, and mechanisms understudy, implementing GA becomes complex in real-world applications in turn considered impractical in a fast-pacing industry (p. 8, 35).

Ćosić et al. (2017) expounded that the vulnerability of human errors is expected to thrive at all times if not suppressed and mitigated given the magnitude of responsibilities. These circumstances yield current selection procedures to be both intensive and structured. For assessing the degree of suitability of an ATCOs applicant in a mentally demanding profession, Costa et al. (1996) and Koninck (2017) provided qualities as psychological parameters as follows; (1) high analytical skills, (2) superior stress tolerance, (3) emotional stability, (4) effective real-time reasoning, (5) ability to make competent choices, (6) split and sustained attention, controllable mental agility, (7) psychologically sound arithmetic and logical reasoning, (8) vigilance. It should be noted that subjects with an outstanding overall degree of cognitive ability tend to be more vulnerable to probable conflict occurrences. Supporting that, the focus of the attention scale of ATCOs demonstrates the psychological state at a specific period (Xiaotian et al., 2017). In addition to this, Li et al. (2019) highlighted that the probability of making poor judgments increases with the degree of cognitive labor placed by operators.

The researchers unraveled a great foundation for propelling human performance in ATCOs as a part of the ATC systems through a comprehensive cognitive assessment. The aim is to further understand how to aid current ATM systems and their operational procedures (Aricò et al., 2016). Considering that Harris and Muir (2017) highlighted the analysis that over the last 20 years, ATCOs operating mistakes attributed to 70% of 90% of human errors. Researchers highlight that monitoring of ATCOs overall performance in assigned duties and responsibilities should never be neglected.

The primary sector of interest of previous researchers focused on patterns and characteristics of operators, quality of equipment used, human factors, stress mitigation, and other contributing psychological factors that affect operation. However, few studies published specifically lay the groundwork for the foundation of a better Philippine Air Traffic Control system. The researchers recognized the discrepancy in the local literature, and this prompted them to further investigate the cognitive state of ATCOs to produce a comprehensive psychological approach toward decision-making and resiliency.

A. Background of the Study

The integration of intelligent automation is anticipated by the aviation industry. This is considered to maximize resiliency and decrease inaccurate human inputs. The researchers acknowledged the gap in local literature in terms of a comprehensive analysis of the fusion of ATC systems and ATCOs as a fundamental step to further enhance and lay grounds for a better Philippine ATC system. This section discussed parameters that aid the study in progressing toward a systematic understanding of ATC's local psychological metrics.

The researchers acknowledged that the term Air Traffic Control Operators (ATCOs) and Air Traffic Management Officer (ATMO) are synonymous in this context. The researchers solely based on the Philippine Civil Aviation Regulation (PCAR) as a reference in the terminology used in this research.

PCAR section 2.2.2.4 states that ATCO applicants will be certified if the requirements for the certificate are met. The organization mandates that the applicant shall undergo a medical examination for both physical and mental requirements. The ATCOs shall hold a current class 3 medical certificate (2.7.3) which is issued under the authorized Aviation Medical Examiner (2.10.1.8). This ensures that ATCOs are meticulously screened and medically fit to perform strenuous mental and physical ATC duties. The applicants shall meet the requirements in age, knowledge, medical fitness, experience, skill, and language proficiency. Researchers elaborated on the requirements connected to the study as follows:

1) Age

Air Traffic Services (ATS) licenses and ratings are required to satisfactorily meet the respect of age not less than 21 (PCAR Part 2 2nd Edition, 2020, p.2.7-1). It should be noted that license validity lasts until 24 months for 39-year-olds and below 12 months for 40-year-olds and above (2.10.1.8). Age-related cognitive decline affects areas such as verbal ability, computation abilities, and general knowledge; a noticeable decline is noted in areas like memory, executive functions, processing speed, and reasoning, suggesting a complex pattern of cognitive aging (Deary et al., 2009).

2) Medical Fitness

Mental Requirements:

Each applicant is subjected to pass a medical examination based on PCAR requirements as a standard procedure and selection process (CAAP manual of standard for ATS, 2020, p.18-3; 18.2.1.1). Applicants are expected to have no medical history or clinical diagnosis of (1) psychosis, (2) alcoholism, or drug dependence, (3) no repetitive actions, (4) personality

disorder, (5) mental abnormality (6) neurosis of a significant degree according to an accredited medical conclusion (2.10.2.4.2) (CAAP, PCAR PART 2, July 2023). The cognitive tests conducted for the issuance of the ATC license measure the following: spatial awareness, multitasking and working memory, reaction time, pattern recognition, attention and concentration, problem-solving and decision-making, stress tolerance evaluation, and communication skills.

Physical:

A candidate applying for any medical assessment category must be devoid of any congenital or acquired abnormalities, as well as any current, hidden, recent, or longstanding disabilities. Additionally, applicants should not have any wounds, injuries, or lingering effects from surgeries, nor should they experience any adverse consequences from either prescribed or non-prescribed therapeutic medications. These conditions, if present, could potentially result in a level of functional impairment that might compromise the safe operation of an aircraft or the effective performance of their duties. (Civil Aviation Authority of the Philippines Civil Aviation Regulations Personnel Licensing, p. 2.10-5; 2.10.2.1.2).

It should be noted that locations of the ATCOs who participated in the study are scattered all over the Philippines. This is further elaborated in Table 1. Parameters mentioned in this section were taken into consideration by the researchers as a basis to guide the paper in the likes of local literature to curate an ideal ATC system that is centered on understanding the Filipino ATCOs neurophysiological state.

B. Theoretical Framework

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C. *Theoretical Framework*

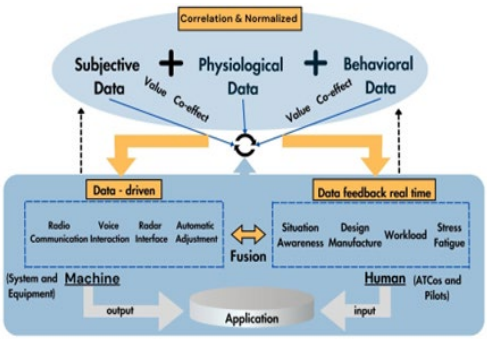

Fig.1. Data-driven system application service (Li et al., 2019)

The theoretical underpinning of the study is based on the evaluation of the variables and parameters mentioned to ensure that the study conducted is directed towards an in-depth understanding of the cognitive evaluation of ATCOs to achieve a comprehensive approach towards decision-making and resiliency. This study is anchored on the ideas of Li et al. (2021) entitled: "A human-centered approach based on functional near-infrared spectroscopy for adaptive decision-making in the air traffic control environment".

The study decoded the implementation of Intelligent Automation (IA) in ATC systems and its dependency on human decision-making capability. This study acknowledged the gap in understanding the role of ATCOs as part of the ATC system rather than an external administrator. The utilized objective-subjective approach determined whether system parameters affected the user. This further verifies the data's veracity, accuracy, and proposed optimal setup to enhance human performance in the ATC environment.

The overall framework proposed by Li et al. (2021) is represented in three layers: data, application, and platform, significantly providing enough data to support the claim. However, the researchers focused on the application platform to satisfy the scope of their study. Figure 1 shows the application service of the data-driven application. This focused on understanding the significance of the Human Factors (HFs) to maximize systems necessary for a better human-machine fusion in the ATC system. The upper hemisphere shows the main correlation and normalized relationship of subjective, physiological, and behavioral data in terms of ATCOs performance. Furthermore, Li et al. (2021) shows the contributing effects of human factors stemming from subjective data, encompassing systems and machines (including; radio communication, voice interaction, radar interface, and radar adjustment). Likewise, behavioral data is derived from ATCOs and the Pilot's input (including situational awareness, design manufacture, workload, stress, and fatigue).

Li et al. 's (2019) analysis of the influence of human errors and cognitive effects on ATCOs performance shows a significant resemblance to the aim of the study. The researchers established the experimental setting of the study to revolve around the following variables; (1) cognitive load, (2) cognitive decline, (3) attention decline, (4) error recovery, (5) stress, and (6) situational awareness - considered factors to significantly affect ATCOs decision-making capability and challenges the projected resiliency of operators. It should be noted that Li's variables namely; (1) design manufacture, (2) fatigue, and other variables associated with physiological assessment were eliminated due to the scope of the study.

D. *Conceptual Framework*

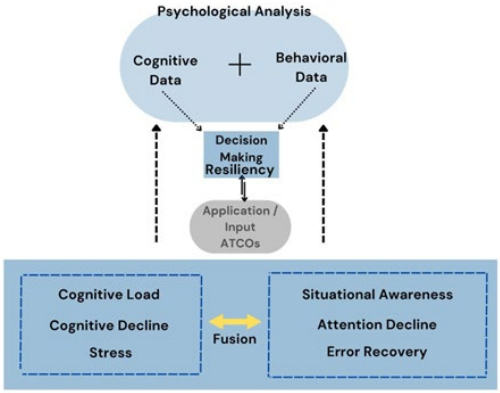

Fig.2. Paradigm on comprehensive ATCOs neuropsychological evaluation towards decision making and resiliency

The framework was curated by the researchers to direct the aims of the study. The variables and parameters mentioned are founded on existing research to establish principles.

Physiological monitoring will remain vital for the ATCOs and aviation research in general. Researchers argue that despite advancements in automation technology humans will remain an essential component in the ATC System (Ćosić, 2019). Lee et al. (2018) and Bernhardt et al. (2019) revealed that the probability of fatigue and committing unfit decisions is rooted in the degree of cognitive attempts exerted by operators. Since passenger safety is heavily dependent on ATC's clearance and instructions, the industry expects no margin of error in every operation conducted. In an ATC selection process, psychological metrics highlight the vital value of; (1) adaptability, (2) stress tolerance and (3) self-control to be connected to resilient functioning. Hence, ATCOs resilience is a particular factor in the ATC selection process (Yehuda et al., 2006 as cited by Ćosić 2019). Considering stress as a well-established human factor component in understanding ATCOs operations, a few pieces of literature discussed stress in ATC as opposed to variables such as situational awareness and workload (Langan-Fox et al. 2010, Falkland and Wiggins 2019, Truschzinski et al. 2018). Costa (2019), and Koninck (2017) presented qualities as psychological parameters to determine if an operator is fit to be in a mentally exhaustive field. ATCOs applicants are evaluated in terms of (1) high analytical skills, (2) superior stress tolerance, (3) emotional stability, (4) effective real-time reasoning, (5) ability to make competent

decisions, (6) sustained attention, (7) controllable mental agility in terms of error recovery, (8) psychologically sound arithmetic and logical reasoning, and (9) situational awareness, (10) resiliency.

The researchers anchored the variables in previous research conducted by Li et al. (2021), Ćosić (2017), and Ćosić (2019). In terms of data acquisition, the researchers utilized cognitive data through subjective analysis and behavioral data through an objective approach to obtain neuropsychological metrics. This paradigm suggested by Li et al. (2019) is a fundamental step to avoid bias in the process and ensure that the data gathered are sufficient to satisfy the aims of the paper. The mentioned authors heavily discuss the importance of psychological analysis in ATCOs in the ATC system. Hence, two layers to further understanding the variables: decision-making, resiliency, and cognitive state. Furthermore, the researchers utilized variables such as; (1) cognitive load, (2) cognitive decline, (3) stress; under cognitive data, while (4) situational awareness, and (5) attention decline (6) and error recovery in behavioral data. This is designed to further understand the decision-making and resiliency in ATCO applications.

To obtain psychological data, the upper hemisphere of the paradigm is broken down into the analysis of cognitive and behavioral. The two main approaches are supported by respective variables shown in Figure 2. The sum of the data gathered revealed how variables affect ATCO's decision-making capabilities and resiliency. Since the researchers designed a cyclical paradigm, the input of ATCOs can be analyzed backward and understand how the variables are affected if ATCOs perform desired decision-making skills and resiliency.

E. Statement of the Problem

Generally, this study aimed to obtain an in-depth cognitive analysis of Philippine Air Traffic Control Operators (ATCOs) to produce a comprehensive approach toward decision-making and resiliency.

Specifically, this aimed to answer the following questions:

1. Is there a significant difference between ATCOs with 0-9 years of experience and 10-20 years of experience in terms of:
   1.1 Cognitive State and Resiliency; and
   1.2 Resiliency and Decision-making capability?
2. Is there a significant relationship between the following in terms of a Philippine ATCO capability:
   2.1 Cognitive State and Resiliency;
   2.2 Resiliency and Decision-making capability; and
   2.3 Decision-making Capability and Cognitive State?
3. What are the Philippine ATCOs current occupational strategy and monitoring parameters to ensure highly competent ATCOs in terms of:
   3.1 Decision-Making: and
   3.2 Resiliency?
4. How are existing psychological factors affecting the decision-making of ATCOs in terms of:
   4.1 Cognitive load;
      4.1.1 Cognitive decline
   4.1.2 Attention decline
   4.2 Error recovery;
   4.3 Situational awareness; and
   4.4 Stress and stress mitigation?

F. Hypothesis

The following hypotheses are formulated based on the statement of the problem indicated by the researchers:

- There is no significant difference between ATCOs with 0-9 years of experience and 10-20 years of experience in terms of Cognitive State and Resiliency; Resiliency and Decision-making capability.
- There is no significant relationship between the Cognitive State and Resiliency; Resiliency and Decision-making capability; and Decision-making Capability and Cognitive State of Philippine ATCO

G. Significance of the Study

Air Transportation and Aviation Students. The result of the study will aid students in better understanding how psychological and behavioral metrics affect ATCOs performance and integrate desirable traits in the strenuous job.

Researchers. This study will benefit the researchers in gauging a deeper understanding of neuropsychological evaluation towards the decision-making and resiliency of ATCOs as a part of an intelligent automation system.

Philippine Air Traffic Controller Association. The result of this study will benefit this sector in terms of supplication and the addition of relevant information regarding the selection of ATCOs in terms of neuropsychological analysis.

ATCOs. The outcome of this study will be beneficial for ATCOs to better understand and maintain their psychological state to minimize errors.

Future researchers. This study is highly beneficial as a reference for future researchers who aim to conduct similar studies. This will stand as a basis to contribute to the advancement of the Philippine aviation industry.

Fig.1. Data-driven system application service (Li et al., 2019)

2. Methodology

A. Research Design

The main pillar of this paper is to maximize the selection process of the Philippine ATCOs concerning the rise of IA. Considering that the development of artificial intelligence is predicted to surpass human performance in the succeeding years (Grace et. al 2018). Removing humans from the ATS is viewed to be currently infeasible amidst its well-developed state- the current strategies are evaluated to be insufficient to process complex situations (Yiu et. al, 2021). Ng et. al (2020) highlighted that ATM momentarily requires human collaboration. Hence, ATCOs involved should have complementary and compatible technical skills for IA. The researchers aimed to further evaluate the cognitive state of ATCOs selected for the Philippine ATMS. This is to ensure that

ATCOs selected are best fit to perform strenuous mental work under stress and immense pressure.

To produce a comprehensive understanding of the paper, the researchers utilized a mixed-method research approach, in particular an Explanatory Sequential Design (ESD). According to Subedi (2016), ESD comprises 2 general phases (1) the collection of quantitative data followed by (2) qualitative data collection. To justify this approach Clark (2011) expounded that quantitative data presents a major portion of the topic understudied. The additional analysis obtained from qualitative data deepens, strengthens, and refines the results gathered. Hence, integrating the strong points of quantitative and qualitative approaches addresses the discrepancies between each other, making stronger points to support the paper (Khaldi, 2017). To further elaborate, the researchers utilized a non-experimental correlational and descriptive approach to justify the quantitative areas of the paper and an interactive narrative approach to further expound the quantitative data through a qualitative research approach.

In phase one, the researchers gathered the quantitative data by using a standardized psychological- Connor-Davidson resilience scale (CD-RISC-25) for resiliency, Raven's Progressive Matrices for cognitive assessment, and Adult Decision-Making Competency for decision-making assessments. This was then followed by phase two- qualitative data collection through an in-depth interview. The supplementary set of data generated from qualitative data collected was obtained and evaluated. This was used as support in elaborating on the quantitative conclusions that were drawn from the initial phase.

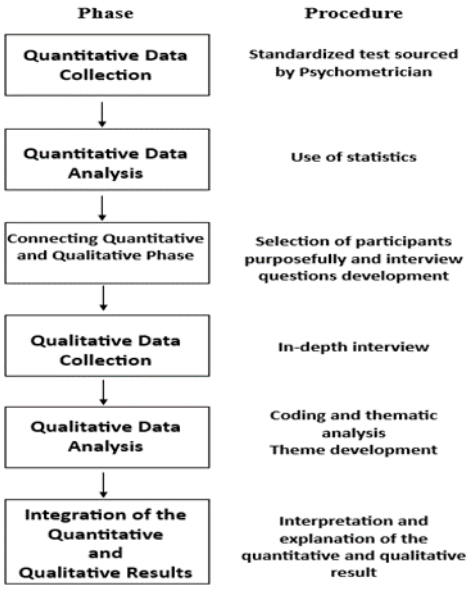

Fig.3. Shows the phase and procedures taken by the researchers patterned to ESD

B. Respondents

This paper was mainly interested in a collection of a target population of ATCOs registered under the Civil Aviation Authority of the Philippines (CAAP). The participants of the study are eligible to participate provided that ATCO holds at least one of the aforementioned ratings based on PCAR 2.7.4: (1) aerodrome control rating, (2) approach control procedural rating, (3) approach control surveillance rating, (4) approach precision radar control rating, (5) area control procedural rating. and (6) area control surveillance rating. In a study conducted by Malakis et. al (2020), he explained that minimal deviation in job complexity was seen from different ratings of ATCO when exposed to high-risk scenarios. Hence, researchers did not limit respondents to only one rating.

The Philippine ATS is composed of 198 ATCOs (CAAP report as of August 2023) assigned to different facilities around the Philippines. The intended sample size is 30 participants at a minimum this is due to the availability of respondents. The researchers gathered 20 ATCO participants elaborated in Table 1. This is done to satisfy the 10% acceptance rate for external responses to the study. The demographic information shows that the majority of the participants are scattered on the main island of the Philippines. Ages are between 26-40 The sexual orientation of participants (male=11; female=9) was not considered to be a factor in the study. This is supported by Cosic et al. (2019) where 40 ATCO candidates did not show a significant difference between male and female respondents. Furthermore, Hyde (2016) highlights that male and female cognitive performance in complex cognitive activities shows no significant difference.

Table.1. Respondents' Data

Category	**n**	**%**
Sex		
Male	11	55%
Female	9	45%
Age		
26-30	5	25%
30-35	10	50%
35-40	5	25%
Rating		
Approach Control Rating	9	45%
En-route Control Rating	4	20%

Tower Control Rating	7	35%
Geographic Location		
Luzon	11	55%
Visayas	5	25%
Mindanao	4	20%

The participants were sampled using a parametric convenience sampling technique- a non-probability sampling frequently utilized in diagnostic and qualitative research. It should be noted that the drive of participants who take part in the study affects convenience sampling in qualitative research (Stratton, 2021). Considering that all participants are active ATCOs, availability, and accessibility were factors taken into account for the parameter setting of the respondents, hence convenience sampling technique was the best fit for the study.

C. Settings

This study mainly focused on the in-depth cognitive analysis of Philippine ATCOs to produce a comprehensive approach toward decision-making and resiliency. The researchers underwent a three-week preparation to curate the research tools mentioned in section 2.4. This included revisions and consultation with two registered psychometricians and an instructor. The selection of the assessment to be given to the participants was thoroughly studied to fit the aims of the paper. Alongside the preparation of interview questions is an in-depth analysis to answer any gaps that were introduced by the quantitative approach.

All necessary data were gathered in eight separate days: five days were dedicated to the written examination done via Zoom. Three days were dedicated to the in-depth interview. The researchers are mostly interested in the relationship and differences between resiliency, decision-making, and the cognitive state of an ATCO. This is to further understand the importance of the mentioned variables on ATCO performance in an IA ATC system.

Delimitations of the study identified by the researchers were the possible bias that had risen considering that psychological assessments are susceptible to false reports by respondents. In addition to this, participants of the study were geographically located in different parts of the Philippines which could be a factor to consider that may affect the results.

D. Instrumentation

Human factors is a major field of study in aviation psychology. Kelly and Efthymiou (2019) acknowledged that it is challenging to completely eradicate human errors and mitigating them will never be fully effective. However, understanding the vast intellect of an aviator narrows the chances of orchestrating a human error-induced accident.

1) Phase 1 (Cognitive testing: 1st Layer)

The participants were instructed to take the assessment in a controlled environment to eliminate distractions. To ensure that parameters were met, the researchers conducted parameter checks for controlled environments before the assessment began- controlled lighting and temperature in the room. To ensure that assessments were conducted with all accuracy. The researchers received guidance from an external psychometrician in translating the manual to enhance the comprehension regarding the assessment. The participants underwent three written psychological tests. However, due to the complexity of availability and time schedules, the test was administered online via Zoom and was proctored by a registered psychometrician. The parameters for the test are as follows:

- Connor-Davidson Resilience Scale (CD-RISC-25): includes 25 items, for each is scored on a 5-point scale (0–4), with higher scores indicating stronger resilience. (Connor and Davidson 2003). The duration of the assessment lasted for 15 minutes;
- Raven's Progressive Matrices: is a comprehensive test for general cognitive ability composed of five problem-solving sets (Raven and Raven 2003). The duration of the examination was 60 minutes;
- Multi-domain Decisiveness Test: is an assessment that gauges the ability of each individual to make both broad and specific decisions- utilizing a 6-point Likert scale. The duration of the examination was 25 minutes.

It should be noted that participants were divided per batch according to the availability of respondents.

2) Pre-phase 2 (Screening)

The interview was conducted by the researchers to further elaborate the results of the study. There were three notable ATCO who were willing to share their experiences to further understand the underlying reason behind the results of the quantitative data. The researchers selected the following ATCO to represent the main islands of the Philippines to remain comprehensive.

- Informant 1 is a 31-year-old ATCO with six years of experience in operation- currently assigned in Visayas
- Informant 2 is a 31-year-old ATCO with seven years of experience in operation- currently assigned in Mindanao
- Informant 3 is a 40-year-old ATCO with 16 years of experience in operation- currently assigned in Luzon. It should be noted that Informant 3 is accompanied by Informant 3.2 due to their work schedules. The researchers allowed this since both informants were from the same location and followed the same procedures.

3) Phase 2 (Interview Stage: 2nd Layer)

The researchers prepared interview questions seen in Appendix C. The questions were patterned to answer the objectives of the study and were referenced to existing literature. The questionnaire was verified by two registered

psychometricians and an Air Transportation instructor for the question to undergo accurate revisions.

Data collection lasted three days - one per interviewee. This is to ensure data organization and gradual understanding of the researchers about the variables. The duration of the interviews lasted 45 minutes- 60 minutes per ATCO. The interviews were scheduled a week after the analysis of the psychological assessment mentioned above.

E. Data Analysis

The Data analysis of this study included two sections due to the approach used; (1) Quantitative data analysis and, (2) Qualitative data analysis.

1) Phase 1 (Quantitative Data Analysis)

Data analysis for the quantitative approach was evaluated using Jamovi 2.3.19. Shapiro-Wilk test was performed to determine if the parametric test would be used in addressing the research objectives. This is to determine if data will be undergoing a parametric or non-parametric test- supported by Levene's test for homogeneity. Afterward, a paired-sample t-test was used to meet the normal distribution of the data. The comparison of decision-making, resiliency, and cognitive state of an ATCO- simultaneously conforms to the normal distribution without any outliers. To analyze the relationships of the variables, Pearson R correlation was used.

2) Phase 2 (Qualitative Data Analysis)

The data gathered by the researchers were analyzed through an Inductive Thematic analysis. Thus, researchers expected that codes and themes emerged exclusively from the personal analysis of the researchers. The initial coding process used was a combination of In vivo coding which utilized the words of the participant. This was utilized by the researchers to eliminate inferring meaning from data. In addition to this, descriptive code was utilized to summarize extracts by using a single word that encapsulates the general idea of the data provided by the respondents.

F. Ethical Considerations

This study was approved by the ethical committee of PATTS College of Aeronautics. The participants of the study signed a consent form as per ATCO. The researchers gained official permission from respective organizations to use the CD-RISC-25 and Multi-domain Decisiveness Test. On the other hand, the psychometrician legally sourced the Raven's Progressive Matrices. The assessments utilized in this study were verified and approved. The interpretation of the assessments was guided by a psychometrician. The researchers declare no conflict of interest in the study. It should be noted that researchers view this study as an aid to the understanding of the mentioned variables in an ATC in the Philippines. The outcome of the study is in no way questioning the credibility of the authorities-CAAP and its organization. The researchers aimed to contribute to the advancement of Philippine aviation research and to surpass limits and reach greater heights.

3. Result And Analysis

This section is divided into two sections; Quantitative and Qualitative Data analysis.

A. Quantitative Data Analysis

The results of the statistical treatment were done with Jamovi 2.3.19 to make the conclusions in this section.

A normality test, particularly the Shapiro-Wilk test, was performed to determine if the parametric test to be used in addressing the research objectives. If the p-values are greater than 0.05, parametric tests are used. If the p-values are less than 0.05, it means that the data is not normally distributed, so the nonparametric tests will be used.

The research questions posed in this study are once again recalled. Consequently, the findings are presented along with their interpretation and analysis.

Table.2. Normality Test (Shapiro-Wilk)

	W	**P**
Cognitive State	0.91	0.059
Resiliency	0.90	0.052

Note: A low p-value suggests a violation of the assumption of normality

Table.3. Homogeneity of Variances Test (Levene's)

	F	**df**	**df2**	**p**
Cognitive State	0.29	1	18	0.595
Resiliency	1.42	1	18	0.248

Note: A low p-value suggests a violation of the assumption of equal variances

Since both the generated p-values of the Shapiro-Wilk test are greater than 0.05, this implies that the scores are regularly distributed. Moreover, the p-values from the Levene's test are also greater than 0.05, suggesting that the data achieved homogeneity of variance. Hence, to determine if there is a significant difference and relationship among the variables, parametric tests such as the Mann-Whitney U test and Spearman's rho correlation will be employed.

B. Is there a significant difference between ATCOs with 0-9 years of experience and 10-20 years of experience in terms of:

1) Cognitive State and Resiliency

Table 4: Difference in the Evaluation of Cognitive State and Resiliency based on Years of Experience

	t	**p**	**Interpretation**	**Decision**
Cognitive State	0.21	0.833	Not Significant	Accept H0

Resilienc y	-1.33	0.200	Not Significant	Accept H0

	Group	N	Mean	Median	SD	SE
Cognitive State	0-9 yrs	11	50.27	51.00	2.45	0.74
	10-20 yrs	9	50.00	51.00	3.24	1.08
Resiliency	0-9 yrs	11	3.24	3.36	0.35	0.10
	10-20 yrs	9	3.48	3.68	0.46	0.15

Table 4 presents how the evaluation of the cognitive state and resiliency of a sample of ATCO differs when they are classified based on their years of experience. Using the independent sample t-test, it obtained p-values greater than the 0.05 level of significance for the cognitive state (t = 0.21; p = 0.833) and resiliency (t = -1.33; p = 0.200), implying that the null hypothesis will not be rejected. Langer et al., (2017), highlighted that positive cognitive function is affected by factors such as symptom reduction and the development of more favorable ways of coping with one's experiences with greater presence and acceptance. Furthermore, Kalisch et al. (2017) explained that the evidence for the processual nature of resilience comes from a variety of observations showing that people change as they successfully cope with stressors; whether it is a change in outlook on life, the emergence of new strengths or abilities, or a level of partial immunity to stressors, manifested in the effects of future stressors, or as epigenetic changes and changes in gene expression patterns. Hence, the respondents' evaluation of cognitive state and resiliency are the same regardless of how long they have been in the organization.

2) Resiliency and Decision-Making Capability

Table.5. Difference in the Evaluation of Resiliency and Decision-Making based on Years of Experience

	Group	N	Mean	Median	SD	SE
Resilienc y	0-9 yrs	11	3.24	3.36	0.35	0.10
	10-20 yrs	9	3.48	3.68	0.46	0.15
Cognitiv e State	0-9 yrs	11	3.04	3.09	0.16	0.05
	10-20 yrs	9	3.48	3.26	0.42	0.14

	t	p	Effect Size	Interpretation	Decision
Resilienc y	1.33	0.080	0.47	Not Significant	Accept H0
Decision Making	2.53	0.021	0.47	Significant	Reject H0

Table 5 shows how the evaluation of resiliency and decision-making differs when ATCOs are classified based on their years of experience. Analysis of the independent sample t-test test revealed a p-value of less than the 0.05 level of significance for decision-making (t = 2.53; p = 0.021), suggesting that the null hypothesis is rejected. As a result, it can be inferred that there is a significant difference in the respondents' decision-making. In particular, those ATCOs who have been in the institution between 10 and 20 years scored higher in decision-making (57%), based on the effect size. On the other hand, regardless of their years of experience, their level of resilience is the same (t = 1.33; p = 0.080). To elaborate, Kalisch et al. (2017) showed that the evidence for the nature of resilience comes from a variety of observations showing that people change as they successfully cope with stressors; whether it is a change in outlook on life, the emergence of new strengths or abilities, or a level of partial immunity to stressors, manifested in the effects of future stressors. Furthermore, explaining the course of the life of an individual, transitional periods emerge with responsibilities and choices, thus, decision-making capability consistently improves from the adolescence period in which life decisions are made, which are formed and clarified during the onset of adulthood (Colakkadioglu & Celik, 2016).

C. Is there a significant relationship between the following in terms of a Philippine ATCO capability?

1) Cognitive State and Resiliency

Table.6. Correlation Matrix between Cognitive State and Resiliency

		Resiliency	Interpretation	Decision
Cognitive State	Pearson's r	-0.15	Not SIgnificant	Accept H0
	p-value	0.535		

Legend: .00-0.19: Very Weak; 0.20-0.39: Weak; 0.40-0.59: Moderate; 0.60-0.79: Strong; 0.80-1.00: Very Strong

The correlation matrix summarizes the measurement of the relationship between the cognitive state and resiliency. The analysis of Pearson's r correlation revealed a p-value of 0.535, which is greater than the 0.05 level of, suggesting that the null hypothesis will not be rejected and that there is no significant relationship between the variables. It should be noted that emerging professionals gain knowledge from seasoned counterparts, progressively garnering expertise in their occupational roles and fortifying cognitive states and workplace resilience (Marinakou, 2022). The temporal trajectory of individuals is subjected to influential factors shaping experiential learning (Sölva, 2023). The results indicate that the

variables are not statistically connected and that the value of one variable does not grow or decrease in response to the increase or decrease of the other variable.

2) Resiliency and Decision-Making

Table.7. Correlation Matrix between Resiliency and Decision-Making

		Resiliency	**Interpretation**	**Decision**
Resiliency	Pearson's r	0.29	Not Significant	Accept H0
	p-value	0.208		

Legend: .00-0.19: Very Weak; 0.20-0.39: Weak; 0.40-0.59: Moderate; 0.60-0.79: Strong; 0.80-1.00: Very Strong

The correlation matrix summarizes the measurement of the relationship between the cognitive state and resiliency. The analysis of Pearson's r correlation revealed a p-value of 0.535, which is greater than the 0.05 level of, suggesting that the null hypothesis will not be rejected and that there is no significant relationship between the variables. It should be noted that emerging professionals gain knowledge from seasoned counterparts, progressively garnering expertise in their occupational roles and fortifying cognitive states and workplace resilience (Marinakou, 2022). The temporal trajectory of individuals is subjected to influential factors shaping experiential learning (Sölva, 2023). The results indicate that the variables are not statistically connected and that the value of one variable does not grow or decrease in response to the increase or decrease of the other variable.

3) Resiliency and Decision-Making

Table.7.1. Correlation Matrix between Resiliency and Decision-Making

		Resiliency	**Interpretation**	**Decision**
Resiliency	Pearson's r	0.29	Not Significant	Accept H0
	p-value	0.208		

Legend: .00-0.19: Very Weak; 0.20-0.39: Weak; 0.40-0.59: Moderate; 0.60-0.79: Strong; 0.80-1.00: Very Strong

The correlation matrix summarizes the measurement of the relationship between the level of resiliency and decision-making. Since the generated p-value of p = 0.208 is higher than the 0.05 level of significance, the null hypothesis will not be rejected. Hence, the researchers conclude that there is no significant relationship between the variables. This further implies that the variables are not statistically connected and that the value of one variable does not change in response to the value of the other variable changing. Cosic et al. (2019), explained resilience in ATCOs, detailing how prolonged exposure to cognitively demanding scenarios, combined with thorough knowledge of situational solutions has nothing to do with cognitive decline. Highlighting that intentional practice and stress-induced training strengthen ATCOs' resilience and enable them to respond skillfully under pressure.

4) Decision-Making and Cognitive State

Table.8. Correlation Matrix between Decision-Making and Cognitive State

		Decision Making	**Interpretation**	**Decision**
Decision Making	Pearson's r	-0.38	Not Significant	Accept H0
	p-value	0.096		

Legend: .00-0.19: Very Weak; 0.20-0.39: Weak; 0.40-0.59: Moderate; 0.60-0.79: Strong; 0.80-1.00: Very Strong

Table 8 presents the correlation matrix between the possible relationship between decision-making and cognitive state. Using Pearson R. correlation, it yielded a p-value of 0.096, which is greater than the 0.05 level of significance. This means that the researchers will not reject the null hypothesis and will conclude that the variables are not statistically connected and that the value of one variable does not change in response to a change in the value of the other variable. To support these findings, Skagerlund et al. (2020) explained that variables; decision-making competence, and cognitive abilities, did not exhibit any correlation in the study they conducted. Furthermore, their findings identified working memory as the predominant predictor in the application of decision rules. Highlighting a nuanced relationship between cognitive functions and decision-making processes. In addition to this, a similar study regarding cognitive abilities affecting decision errors states that the idea that a systematic link exists between an individual's ability to think and his or her latent risk preferences is rejected. This hypothesis points out that there is a negative correlation between people's ability to think and the number of decision errors. The correlation should not be affected by the use of different heuristics if the task is biased towards risk aversion behavior, hence that random choice behavior leads to a risk aversion classification. In the same study, the hypothesis that a person's cognitive abilities are closely linked to his or her latent risk preferences has been rejected by the other error hypothesis. Instead, the hypothesis states that there is a negative correlation between people's ability to think and the number of incorrect decisions (Mechera-Ostrovsky, 2023).

5) Qualitative Data Analysis

Even though the majority of the data found no significant difference or relationship of the variables. The researchers were prompted to further investigate the underlying factors that

affect the results of the study in the Philippine setting. The result of this study was opposing the theoretical study pattern. Hence, an interview process remained a part of the study.

D. What are the Philippine ATCOs current occupational strategy and monitoring parameters to ensure highly competent ATCOs in terms of:

1) Decision-Making

The variable Decision-making yielded four master themes and eight superordinate themes upon data analysis.

Master Theme	SuperOrdinate Themes
3.3.1.1 Monitoring Parameters	3.3.1.1.1 Document 4444 (Standard Operating Procedures) 3.3.1.1.2 Self-evaluation
3.3.1.2 Deviation from Standard operating procedure	3.3.1.2.1 Severity 3.3.1.2.2 Communication
3.3.1.3 Opposing Opinions	3.3.1.3.1 Weighing Decisions 3.3.1.3.2 Procedures
3.3.1.4 Decision under stress	3.3.1.4.1 Preparedness 3.3.1.4.2 Breaks

Master Theme 3.3.1.1: Monitoring parameters to maintain informed decision-making ATCO

Superordinate Theme 3.3.1.1.1: Document 4444 (Standard Operating Procedures)

Informant 1*: So, in order to decide, you probably need to listen to your training, read the procedures.You study the procedures*

Informant 2: *... you should not deviate too much in the parameters on what is in the procedures ...*

To further elaborate, informants 1 and 2 were queried "What is the role of organization and the monitoring parameters imposed in your decision-making process?". The researchers designated the code *Document 4444* to systematically analyze the response in this context. The question was formulated to oversee how the organization can uphold ATCO performance and comprehend the impact of imposed practices on their decision-making capability. The Procedures for Air Navigation Services - Air Traffic Management (PANS-ATM, Doc 4444) was developed by ICAO as a global standard encompassing procedures to ensure safe air traffic management (Chisholm, 2018). Informant 1 discussed that the organization places significant reliance on the said document as it encapsulates all standard operating procedures in various scenarios encountered in a day-to-day operation. Based on the analysis of the researchers the implication of Document 4444 is justified through a study conducted by Newman et. al, (2020), when decisions are derived from pre-written algorithm decisions that are generated it produces a more objective approach to eliminating human errors, particularly at high-pressure situations.

Master Theme 3.3.1.1: Monitoring parameters to maintain informed decision-making ATCO

Superordinate Theme 3.3.1.1.2: Self-Evaluation

Informant 3: *I act on it with the checklist. For example, we have a flat tire on the runway, we choose what is best for that situation and then we act on it, then we evaluate. So we can know where to improve ...*

Informant 3 was asked the same question concerning the scope of decision-making as a variable. The researchers assigned the code *self-evaluation* as a construct to signify the response of Informant 3. Highlighting the response that an ATCO has to meticulously examine the established procedures and conduct an in-depth evaluation in order to decide which course of action is most suitable for the given situation. Further information was provided by Informant 3, that there is a requisite of constant self-assessment of one's performance and abilities while on duty. Massar et, al. (2016) discussed that outcomes of actions imposed show a significant motivational value on the task which has a major impact on sustained attention performance. In addition, Konstantinidis and Shanks (2014) suggest that DM should be dependent on consciously acquiring knowledge. highlighting the need for vigilance when drawing conclusions about the existence of implicit influences in unreliable decision-making, particularly if you employ poor approaches to evaluate awareness (Konstantinidis & Shanks 2014).

Master Theme 3.3.1.2: Deciding in terms of deviation from Standard operating procedure

Superordinate Theme 3.3.1.2.1: Severity

Informant 1: *... you prioritize arrivals based on the severity, whether they really need to go first in the sequence ...*

Informant 1 was interrogated with the following query: "Acknowledging that Air Traffic Control follows standard procedures, how do you decide to give instructions if a particular situation is not covered by standard operations?". This question aims to evaluate how the ATCO processes its decisions when confronted with situations outside the scope of Document 4444. The researchers designated *severity* as a code for the response of informant 1- discussing Document 4444 comprehensively encompasses operating procedures and no ATCO should induce major deviation that might jeopardize the safety of the flight. In nature, ATC employs multi-criteria decision-making (MCDM), this signifies that weights of decisions are assigned to certain criteria that correspond to a critical part of their DM process (Dragan et al., 2018). Furthermore, if decision-makers are faced with two options; (1) deviate or (2) follow Document 4444, Odu (2019) elaborated that they may exhibit a lax or strict preference for one option over another and may find it difficult to identify which should be the most desired because it is hard to tell one option from another. However, if ATCO can follow judgments based on standard procedures it would lead to a more unbiased approach that eliminates inaccuracies.

Master Theme 3.3.1.2: Deciding in terms of deviation from Standard operating procedure

Superordinate Theme 3.3.1.2.2: Communication

Informant 2: *... what we do is we log it, then collaborate on it and talk about it with other facilities. We set up a team regarding the incident so that we're able to create a procedure and then we create a letter of agreement when the next time that situation ...*

The researchers asked the same question to Informant 2. The code assigned was *communication* as a construct to represent the answer of informant 2. Given that the practice of safety in the aviation industry is the most important requirement that aviators must observe (Majid et. al. 2022). Informant 2 indicated that when there are deviations from standard operating procedures, communication within the team is crucial to assess if the deviation was intended to enhance safety or result from human error. Casey and Krauss (2013) explained that intra-team safety communication has been proven to contribute significantly to the prediction of safety behavior in the setting of safety dynamics within a team. Informant 2 highlighted that they can have a positive assessment of committing errors. This could be supported by Cigularov et. al (2010) explaining that employees are more likely to practice appropriate safety behaviors when there is a favorable climate surrounding error management. This tendency is explained by the fact that error-related behaviors and their proven relationship to positive safety outcomes are similar.

Master Theme 3.3.1.3: Impact of differences in opinion and organizational hierarchy in ATCO decision-making

Superordinate Theme 3.3.1.3.1: Weighing Decisions

Informant 1: *... the supervisor is the one who will decide for me. What I can do there is express what I think is the efficient way to resolve this issue. I'll present it to them, and then, well, they will be the one to decide on it ...*

To gain deeper insights into decision-making in the context of ATC, Informant 1 was asked, "Acknowledging opposing opinions from higher position employees or supervisors, how do you settle in a decision?". Based on the response of the informant, the researchers assigned the code *weighing decisions*. The researchers behind this question aimed to gauge how ATCO can manage the process of making decisions when there are procedural disputes during operational scenarios. Informant 1 explained that in cases of decision-making hesitations, the best course of action is to consult the designated supervisor. Using cooperative analysis, the purpose is to identify which resolution is more effective in resolving the particular scenario under consideration. Dobrowolska (2020) explained that supervisors having longer years of seniority are mentally resilient, defined by qualities such as endurance, optimism, the capacity to tolerate difficulties, and the ability to handle complicated emotions. In addition, Informant 1 highlighted that the decision made must best suit the situation regardless of who it was from.

Master Theme 3.3.1.3: Monitoring parameters to maintain informed decision-making ATCO

Superordinate Theme 3.3.1.3.2: Procedures

Informant 2*: ... we have nothing to say or to oppose. All of us will just agree on it since it is published in the procedures ...*

Informant 3: *We don't question the authority of the supervisor because they usually know what to do. If it's questionable, we open the book, then the instructor will acknowledge that.*

Informants 2 and 3 were asked the same question. Upon analysis, the researchers found similarities in the responses and coded them as *procedures*. Both informants reported that despite the differences in opinion and organizational hierarchy, adherence to the standard procedures is a must to ensure safe operations. Decision-makers can use this technique as they determine what is necessary next as well as evaluate which areas need to be addressed to close any gaps before the execution phase begins (Nasseef et al, 2021). This was explained in master theme 1, superordinate theme 1.1 explaining the importance of document 4444 in the context of ATM.

Master Theme 3.3.1.4: Decision under stress

Superordinate Theme 3.3.1.4.1: Preparedness

Informant 1: *I already pre-planned the possibilities that could happen to this aircraft, something like that. So, in case it doesn't follow or accept this instruction, I have a plan B.*

To elaborate, Informant 1 was asked "How do you analyze your decisions while experiencing stress?". Based on the responses of the informants, the researchers assigned the code *preparedness*. The researchers aim to deepen the understanding of how an ATCO can navigate through stressful situations, considering the significant impact of stress on human performance. The response of Informant 1 highlighted that to prevent excessive stress in the event of an emergency, it was emphasized the relevance of having a pre-established plan in place. In a study conducted by Paton (2019), the resulting need to look more into the social and psychological mechanisms that impact whether and to what degree individuals prepare for hazard occurrences has led to preparation becoming a topic of substantial psychological interest. Approach techniques incorporate cognitive and behavioral procedures intended at producing an active reaction to the stressor, directly addressing the problem or the unpleasant feelings connected with it, thus, this category covers techniques such as planning, taking particular action, obtaining help, a positive evaluation of the circumstance, and acceptance (Freire, 2020).

Master Theme 3.3.1.4: Decision under stress

Superordinate Theme 3.3.1.4.2: Breaks

Informant 3: ... *if you are sick, just go home if you can't do it anymore. Callyour supervisor or tap your mate "Mate, I can't do this anymore". It's okay to do that ...*

Informant 3 was asked the same question. The researchers assigned the code *breaks* concerning the analysis of Informant 3's response. The response emphasized that an air traffic controller's ability to make sound choices is significantly linked to the effectiveness of their duties. The significance of identifying and managing stress was pointed out, with the suggestion that an ATCO could proactively allocate jobs and request a period of rest if they are experiencing excessive stress. This preventive action is put in place to protect the integrity of aviation safety that is managed by them. In a study conducted by Porcelli and Delgado (2016), when it comes to decision-making, stress may have an impact on numerous levels, from altered valuation/feedback processing and automaticity effects to increased decision-making capability. Sleep deprivation has been associated with worse decision-making quality across several domains, lowering the capacity to make effective judgments, according to behavioral research. In decision-making under ambiguity, sleep loss has been linked to an increased proclivity to accept risks. Furthermore, sleep deprivation impacts economic choices and decision-making capability (Salfi et al, 2020).

The variable Resiliency yielded three master themes and six superordinate themes upon data analysis.

Master Theme	Superordinate Themes
3.3.2.1 Factors Indicating Resilience	3.3.2.1.1 Training 3.3.2.1.2 Experience
3.3.2.2 Personal Challenges	3.3.2.2.1 Pandemic 3.3.2.2.2 Death
3.3.2.3 Organizational Initiatives	3.3.2.3.1 Events 3.3.2.3.2 Training

2) Resiliency

Master Theme 3.3.2.1: Factors Indicating Resilience
Superordinate Theme 3.3.2.1.1: Training
Informant 2: ... *well equipped and knowledgeable in the correct procedures, that is what I think that an air traffic controller is resilient, well trained and well knowledgeable in procedures ...*

In order to elaborate on the analysis outlined in this table, Informant 2 inquired: "When can an ATCO be considered resilient?". The researchers assigned the code *training* to the response of the informant. The question aimed to further understand resilience in the context of ATC and identify a resilient ATCO. Informant 2 highlighted that resiliency is gained through training. If an ATCO can retain the learnings he/she gained from the training he/she has a greater trajectory of predicted resiliency. People who report higher levels of emotional tiredness and weaker resilience also report worse perceived health. (García-Izquierdo et al., 2018) Some scholars have proposed that resilience is a learnable and developable personal attribute. Resilience is an individual talent utilized to face unfavorable situations. Training exercises that concentrate on enhancing this ability are crucial in this regard. (Rieckert et al., 2021)

Master Theme 3.3.2.1: Factors Indicating Resilience
Superordinate Theme 3.3.2.1.2: Experience
Informant 1: *So I can say we were resilient during that time because, of course, it was a pandemic, right? And we needed to do duty to continue our responsibilities as Air Traffic Control even though there was a virus.*

Both Informants 1 and 3 were asked the same question as Informant 2 regarding the qualities of a resilient ATCO. After analysis, the researchers assigned the code *experience* to summarize the ideas of both respondents. They revealed that resiliency is gained through experience. Highlighting their services during the pandemic and other personal battles they fought. Informant 2 said that no matter what happens it is their duty as an ATCO to maintain the safety of the Philippine aviation industry. A contextualized approach is necessary for studying resilience since social ecosystems and individuals form dynamic partnerships that can result in good adaptation in the face of adversity. (Ungar, 2011 as cited by Kim et al. 2022) In a study by Masten (2018), resilience is defined as the capacity of a system to adapt successfully to challenges that threaten the function, survival, or future development of the system. Acknowledging that individuals in their later years are influenced by past experiences. (Sölva, 2023)

Master Theme 3.3.2.2: Personal Challenges that affect an ATCOs Resilience
Superordinate Theme 3.3.2.2.1: Pandemic
Informant 1: *scenario from the pandemic. So actually, during the pandemic, you couldn't have anyone in your operations*
Informant 2: *at the time of pandemic, I guess because there was a lockdown and then we are not able to go outside the tower cab, so for me the resiliency to sadness*

Informants 1 and 2 were asked to "share some experience regarding resiliency". The research aimed to gauge practical scenarios where informants were able to practice their resilience. Upon analysis, the researchers designated *pandemic* as a code for their response. Informants 1 and 2 both stated that the COVID-19 pandemic severely challenged their operational resilience. Informant 1 stated that minimizing socialization due to the pandemic protocols added as a factor to challenge his resilience while Informant 2 disclosed that it affected the emotional part of his cognitive thinking. Enhanced resilience is directly linked to more favorable outcomes when facing crises,

managing chronic diseases and pain, and promoting both emotional and physical well-being (Kim et al., 2018). Existing research indicates that psychological resilience plays a crucial role in maintaining mental health amid the challenges posed by the COVID-19 pandemic (Heath et al., 2020). Numerous studies consistently highlight strong connections between resilience and overall well-being, life satisfaction, and quality of life (Brady et al., 2018). Notably, Labrague et al. (2021) found that resilience significantly reduces anxiety related to COVID-19, serving as a valuable protective factor.

Master Theme 3.3.2.2: Personal Challenges that affect an ATCOs Resilience

Superordinate Theme 3.3.2.2.2: Death

Informant 3: *my biological mother died last October 30. But I did not feel affected because life must go on. Accepting the fact that these things happen and might happen soon. So, I didn't make it as an excuse to decline my other commitments.*

Informant 3 was asked the same question. The researchers assigned the code *death* upon analysis. Informant 3 mentioned that the death of an immediate family affects the emotional state of an ATCO. However, it is not an excuse to jeopardize the safety of a flight. Informant 3 highlighted that the personal factors that potentially affect performance during operations should be minimized or eliminated if possible. In a study by Walsh (2020), acute crises and loss events, disruptions in various facets of life, and continuous multi-stress challenges with changing circumstances are all characteristics of the COVID-19 pandemic as a stress condition. These conditions can last for months or even years, resulting in continuous deaths and a global chain reaction of disruptions. Exposure to detrimental experiences can yield resilience and positive outcomes, such as fortifying one's sense of purpose and facilitating successful adaptation and self-reflection (Tabibnia, 2020). As asserted by Sarkar (2017), a forward-thinking personality is pivotal for advancement, as it indicates an individual's capacity to navigate personal development, especially when faced with challenges.

Master Theme 3.3.2.3: Organizational Initiatives to maintain a resilient ATCO

Superordinate Theme 3.3.2.3.1: Events

Informant 1: ... *through PATCA, they organize mini events, like sports festivals, perhaps for our camaraderie, and, you know, to become more resilient ...*

The researchers asked the informant: "Can you share the existing strategies, parameters, or policies that make an ATCO resilient". The objective of examining the organizational role in preserving resilience. The researchers assigned the code *events* to the response of Informant 1. Discussion focuses on organizational initiatives that involve social events, such as sports festivals, social nights, and other conferences intended to promote camaraderie and interaction. Through this ATCOs can respite from their professional duties, facilitating the cultivation of rejuvenating perspectives. According to Yang et al (2023), work engagement refers to a positive work-related state of fulfillment characterized by vigor, dedication, and absorption. Employee recognition encounters can enhance work engagement through various mechanisms. This mutually reinforcing behavioral exchange not only provides constructive feedback but also encourages and recognizes individuals' efforts. (Yang et al. 2023) It demonstrates real admiration for their achievements (Zhao et al., 2022) instilling a strong sense of worth and significance in their contributions. As a result, this dynamic increases overall work engagement. Employee recognition acts as a potent catalyst, pushing others to emulate similar great conduct. (Xenikou, 2017) This emulation, in turn, drives individuals to improve their work ethic, conduct, and strive for higher levels of achievement. (van Woerkom et al., 2020)

Master Theme 3.3.2.3: Organizational Initiatives to maintain a resilient ATCO

Superordinate Theme 3.3.2.3.2: Training

Informant 2: *The strategies you're going to do, do not deviate too much on what is in the procedure to say at least you're still following the standard*

Informant 3 for me is the standard. If you know about Document 4444, that is where you will base your decision-making. Every move we make should be based on the international standards of ICAO.

The same question was asked to Informants 2 and 3. Upon analysis, the researchers assigned the code *training* to the response of the informant. Both informants suggested that the organization places a strong emphasis on the usage of Document 4444. Informant 3 highlighted that the procedures are necessary to consistently attain safety- it makes an ATCO resilient by default. According to Wong (2023), utilizing a standardized manual for training establishes a reliable and clear framework, ensuring uniformity in information delivery and equipping employees with standardized skills and knowledge. In addition to this, adherence to such manuals can fortify individual resilience within the workplace by offering consistency, structural guidance, skill development, accessible reference materials, performance benchmarks, adaptability, and the cultivation of team cohesion. The shared adoption of a training manual by an entire team cultivates a common understanding and communication style among team members.

E. How are existing psychological factors affecting the decision-making of ATCOs in terms of:

1) Cognitive load

1.1) Cognitive decline

The variable Cognitive decline yielded three master themes and eight superordinate themes upon data analysis.

Master Theme	Superordinate Themes
3.4.1.1.1 Decline in Mental performance	3.4.1.1.1.1 Duration 3.4.1.1.1.2 Age
3.4.1.1.2 Factors Influencing Decline	3.4.1.1.2.1 Time of duty 3.4.1.1.2.2 Physical Fatigue 3.4.1.1.2.3 Pressure (in terms of traffic volume)
3.4.1.1.3 Coping strategies	3.4.1.1.3.1 Prioritize 3.4.1.1.3.2 Rest 3.4.1.1.3.3 Exercise

Master Theme 3.4.1.1.1: Decline in Mental Performance
Superordinate Theme 3.4.1.1.1.1: Duration
Informant 1: *But usually, our supervisors give us a duty to work for a maximum of four hours, right? So you'll also feel it if you're sitting while you are sitting for more than four hours; it's also tiring. And you'll feel the decline in your performance, and of course, that's directly related to safety, right?*
Informant 2: *but usually the last 30 minutes you get slightly stressed that is when mental stress usually occurs, in the last 30 minutes of your duty.*

Informants 1 and 2 were both asked the same question: "At which point does mental performance decline during operations? Could you tell me when that usually happens?". The researchers assigned the code *duration* to emphasize the idea of both informants. Based on their answers, the factor that causes a decline in mental performance is the work duration. Informant 1 said that they are assigned to work for a maximum of four-hour shifts, however, a decline in mental performance appears after the maximum given working hours has passed. Szakács et al. (2022) explained that a frequent change in shift schedule disrupts the circadian rhythm, resulting in metabolic and hormonal alterations that can have a tremendous influence on one's behavior and cause one to feel genuinely inferior to oneself during a particular performance. Informant 3 explained that the last half-hour of duty is the most crucial time for them because of the mental exhaustion that they are starting to feel. Workplace duration and intensity of physical work appear to be significant determinants in the decline in physical performance caused by mental weariness (Cutsem et al. 2017).

Master Theme 3.4.1.1.1: Decline in Mental Performance
Superordinate Theme 3.4.1.1.1.2: Age
Informant 3: *Our seniors tend to have trouble absorbing new information because of old habits they can't stop doing, and it is really hard to introduce new systems to them.*
Informant 3 was asked the same question as informants 1 and 2: "At which point does mental performance decline during operations? Could you tell me when that usually happens?". Informant 3 explained that one factor that causes a decline in mental performance is the effects of age, thus, the code assigned by the researchers is *age*. Normal aging causes measurable changes in cognition, thus, the most significant alterations include reductions in cognitive activities that involve rapid processing or transformation of information to make a choice (Murman, 2015). Coping with the advancement of technology and up-to-date software, aged professionals are experiencing difficulties in adjusting, therefore, workers' performance looks to be declining as a result of a loss in their general physical and mental ability as a result of workforce aging (Caporale et al., 2022).

Master Theme 3.4.1.1.2: Factors Influencing Decline
Superordinate Theme 3.4.1.1.2.1: Time of Duty
Informant 1: *perhaps working for more hours than...if you work for more than six hours, it really becomes a safety issue.*

Informant 1 was asked the question: "What are the factors that cause these declines?". The researchers assigned the code *time of duty* to gain insights into factors that greatly influence the decline to work cognitively. Based on the answer of Informant 1, the time of duty greatly affects the capability to mentally work when working for more than the required hours contributing greatly to cognitive decline. As stated by Kaliyaperumal et. al, (2017), the time of work duty affects several cognitive domains resulting in impaired sleep deprivation among employees that sometimes causes errors at work. Work shifts are considered detrimental to the safety of the employees and the workplace due to long-term effects based on factual evidence from shift-work industries that are related to unfavorable long-term effects that result in fatigue, sleep deprivation, and major health concerns (James, 2020). These factors contribute to the overall well-being and performance capability of an individual to be fit for work.

Master Theme 3.4.1.1.2: Factors Influencing Decline
Superordinate Theme 3.4.1.1.2.2: Physical Fatigue
Informant 3: *... fatigue is still the cause, that's why sometimes I'm being forced to call out to my supervisor that I can't do it anymore ...*

Informant 3 was asked the same question: "What are the factors that cause these declines?". The researchers designated *physical fatigue* to know its influence on cognitive decline. Informant 3 explained that fatigue is the main factor that they consider as influential in terms of cognitive decline at work. The link between acute physical activity and cognitive performance was not as obvious as previously thought, thus, the literature on the subject tended to yield rather inconsistent results (Abd-Elfattah et al., 2015).

Master Theme 3.4.1.1.2: Factors Influencing Decline
Superordinate Theme 3.4.1.1.2.3: Pressure
Informant 2: *I guess for me is pressure. When there are lots of calls and at the same time, you're a little bit stressed*

Informant 2 was asked the same question as Informant 1: "What are the factors that cause these declines?". Informant 2 explained that the pressure that he is experiencing is because of the volume of calls due to heavy air traffic, thus, the code

assigned by the researchers is *pressure*. Due to multiple tasks that need to be done, high pressure among traffic controllers is related to communication due to the intense volume of air traffic within the manageable airspace (Wang et al., 2016). Under pressure times, workload is directly affected by factors that revolve around the intensity of the tasks, the time allotted, and the capability of the individual. As stated by Yang (2017), under pressure times, three main points are raised that affect ATC workload: these are classified as time-based factors, task intensity-based factors, and the operator's psychophysiological state. Thus, high mental pressure causes deteriorated performance in air traffic management.

Master Theme 3.4.1.1.3: Coping Strategies
Superordinate Theme 3.4.1.1.3.1: Priorities
Informant 3: F*or me, it's the order of priority. I have to do a lot of things. I am an officer, training officer, and at the same time, I am with CAAP. That is why I need to arrange my priorities. I firstly do the things that are urgent. I always have a to-do list, so I know what to do next, to avoid a collision of duties, so I won't be overwhelmed by the things I have to do.*

Informant 3 was asked the question: "What procedures or techniques do you take to cope with cognitive overload at work in an efficient manner?". The researchers aim to point out the coping procedures and strategies performed by the respondents to be able to work efficiently and effectively. The researchers designated the code *priorities*. The informants explained that an organized order of priorities eases the workload and takes control of the things that need to be done to perform efficiently. Freire et al. (2020) stated that the ability to take over the control of decision-making and mobilize actions to attain personal objectives and task completion is an integral psychological resource. Facing a tough and challenging situation sometimes leads to the depletion of resources to cope with it, thus, the priority of evaluating and examining situations activates a Problem-focused coping strategy which mobilizes own actions for a problem solution (Takács et al, 2021).

Master Theme 3.4.1.1.3: Coping Strategies
Superordinate Theme 3.4.1.1.3.2: Rest
Informant 2: *I walk around or look around at the window to refresh my mind*

Informant 2 was also asked the question: "What procedures or techniques do you take to cope with cognitive overload at work in an efficient manner?". The researchers assigned the code *rest*. Informant 2 explained that rest is the most effective way to cope with the stress at work, walking and looking out the window refreshes the mind and emotional feelings of an individual. As stated by O'Hagan (2019), sleep deprivation and weariness are linked to decreased cognition, worse working performance, higher mistake rates, and ultimately decreased safety. Based on a manual stated by Barrett et al., (2020), Stress Management Techniques largely contribute as a resting parameter of ATCOs through physiological practices in being able to cope with cognitive decline. Healthy lifestyles such as enough sleep and good lifestyle habits are the top priorities for ATCOs.

Master Theme 3.4.1.1.3: Coping Strategies
Superordinate Theme 3.4.1.1.3.3: Exercise
Informant 1: *during your long break, try to exercise or eat properly. That's just my personal opinion.*

Informant 1 was also asked the question: "What procedures or techniques do you take to cope with cognitive overload at work in an efficient manner?". The researchers designated the code *exercise*. Informant 1 explained that during their free time, doing exercise as a coping mechanism helps to ease stress and maintain a healthy lifestyle. Exercise is one of the stress-reduction techniques that may be beneficial. Converging data has repeatedly shown that exercise and physical activity are useful for reducing stress and its effects (Sharon-David, 2017). Physical activities are demonstrated to be useful at lowering stress, inducing relaxation, and providing a diversion, which are all regarded as excellent methods of stress management (Cairney et al., 2014).

F. How are existing psychological factors affecting the decision-making of ATCOs in terms of

1) Cognitive load

1.1) Attention decline

The variable Attention decline yielded two master themes and four superordinate themes upon data analysis. Shown in Table. 3.6

Master Theme	Superordinate Themes
3.4.1.2.1 Factors influencing attention	3.4.1.2.1.1 Traffic volume 3.4.1.2.1.2 Experience 3.4.1.2.1.3 Time
3.4.1.2.2 Pressure affecting attention	3.4.1.2.2.1Resistance

Master Theme 3.4.1.2.1: Factors influencing attention
Superordinate Theme 3.4.1.2.1.1: Traffic volume
Informant 1: *... the work is stressful when you say ATC. but sometimes, it depends on the time of the day ...*

To elaborate Informant 1 was queried: "How would you describe the effects of your work difficulty and workload on your attentiveness as an Air Traffic Controller?". The aim of the researchers in line with this question was to identify what affects their attention decline. After the researchers analyzed the response, the researchers designated a code *traffic volume* to the response of the informant. The informant revealed that in his personal experience, the amount of traffic flow heavily affects his attention. The greater the volume of traffic, the more mental effort is required, the faster attention declines. When ATCOs work-intensive task monitoring where their attention is

always occupied. When workload increases, ATCOs are required to cope up with their attention span which over time results in performance decline (Li et al., 2021).

Master Theme 3.4.1.2.1: Factors influencing attention
Superordinate Theme 3.4.1.2.1.2: Experience
Informant 2: *... when it comes to attentiveness we are slightly used to when it comes to being attentive. So it helps especially in our daily lives because in the office we are used to being attentive ...*

Informant 2 was asked the same question as Informant 1. Upon analysis, the researchers utilized the code *experience* to represent the response of information 2. The informant conveyed that an extended attention span is intricately tied to one's level of experience. In addition, he added that it is significant to gain a longer attention resistance since the ability to focus for an extended amount of time is emphasized as an important part of the operation in the context of ATC. As stated by Aricò et al., (2017). ATCOS were used to work in a compound system which includes dealing with computer and human systems. With the help of new technologies today, ATCOs can easily handle multiple aircraft at the same time without having a problem. Hence, these strategies help ATCOs to provide reliable information to the pilot and can adapt easily which helps them to focus more on doing their job (Arico et al., 2017).

Master Theme 3.4.1.2.1: Factors influencing attention
Superordinate Theme 3.4.1.2.1.3: Time
Informant 3: *Your attentiveness is good for only 2 hours. That is why our schedule is 2 hours duty, 2 hours break, and then another 2 hours duty, and 2 hours break. You only have 4 hours of duty ...*

Informant 3 was asked the same question to strengthen the understanding of the researchers about the factors that may influence the attention of an ATCO. The researchers assigned the code *time* for the response of Informant 3. The response included the time assigned per duty. Upon analysis, the researchers were able to establish a correlation between attention decline and time as per the response of Informant 3- the longer the time, the more pronounced decline of attention. As stated by Chang et al., (2019). Having a perfect timing of food break time is a huge factor for the ATCOs to maintain resiliency and avoid human error. Fatigue not only affects the pilot but also the air traffic controller (ATC), they experience a lot of pressure which affects their mental and physical state. Chang et al., (2019) used the Samn-Perelli fatigue scale to measure the stress level affecting the performance of the ATCOs. The test result shows significant differences between day and night shift schedules. The result also shows the importance of the break time of the ATCOs when deciding the schedule of each ATC after finishing their task during their shift.

Master Theme 3.4.1.2.1: Role of pressure affecting attention
Superordinate Theme 3.4.1.2.1: Resistance
Informant 3: *... pressure is affected when it comes to your attentiveness but once you get used to it, it's like being in pressure will just be normal. For attentiveness I think it has a factor if you're still new ...*

To elaborate, Informant 3 was asked the question: "How does pressure or intense situations affect your work attentiveness?". The researchers assigned the code *resistance* based on the response from the informant. The researchers with the situation aimed to comprehend the impact of pressure on the decline of attention within the context of ATC. Informant 3 revealed that pressure is part of the operation, however, resistance to it is gained through experience. The researchers were able to conclude that the greater the years of experience the more resistant you are to pressure hence the more you can retain attention. When it comes to the workplace, personnel who are less experienced learn from those who are way more experienced, especially in times of pressure. Through time they learn from them, making them experienced on their job resulting in them being resilient within the workplace (Marinakou, 2022).

1.2.) Error recovery

The variable Cognitive Error recovery yielded two master themes and four superordinate themes upon data analysis. Shown in Table. 3.7

Master Theme	Superordinate Themes
3.4.2.1 Response to errors in procedures	3.4.2.1.1 Take-over 3.4.2.1.2 Investigation
3.4.2.2 Coping with error	3.4.2.2.1 Momentary rest (as advised by the supervisor) 3.4.2.1.2 Learn

Master Theme 3.4.2.1: Response to errors in procedures
Superordinate Theme 3.4.2.1.1: Take-over
Informant 2: *... the controller beside you will automatically take over you until you're able to think clearly and ready to be back again ...*

Informant 2 was asked with a question related to cognitive self-control regarding the recovery from committing errors, the question: "What are the procedures if an error is committed?". Based on the answer of Informant 1, the researchers assigned the code *take-over*. The informant explained the moment that they committed an error during work, most of the time, their fellow operator would take over for the meantime until they could assess and process the situation. If safety concerns arise

during the controllers' work, they can alert the supervisor by activating the 'supervisor attention button' on their workstation's interface, prompting the sector's supervisor to respond to the situation (Callari et al., 2019). In civil aviation, the safety of flights and individuals is closely intertwined. This involves adhering strictly to workflow protocols in overseeing tasks and integrating advanced management concepts using scientific methods to elevate work quality (Zhao, 2018).

Master Theme 3.4.2.1: Response to errors in procedures
Superordinate Theme 3.4.2.1.2: Investigation
Informant 3: *... but when the error is heavy, you will be pulled out. You, your supervisor, and a safety officer will be interviewed ...*

Informant 3 was also asked the question related to response to errors in procedures, the question: "What are the procedures if an error is committed?". The researchers assigned the code *investigation*. Based on the informant's answer, during heavy situations at work, committing errors could lead to a serious call-out for an investigation on what happened. Informant 1 explained that the procedure they are taking involves calling out the operator that committed an error and beginning an investigative process. Based on Callari et al., (2019), the controller alerts the supervisor using the 'supervisor attention button' and receives a paper document to fill out, containing basic details about the incident. Thoroughly examining specific circumstances that resulted in an accident can offer valuable understanding regarding how managers and teams execute their responsibilities, and how their actions or lack thereof played a role in the accident (French & Steel, 2017).

Master Theme 3.4.2.2: Coping with error
Superordinate Theme 3.4.2.2.1: Momentary rest (as advised by the supervisor)
Informant 2: *... for example, they prove that you're the one at fault your supervisor insist that you go on a vacation then lets you come back after a week so that your mind will be refreshed*

Informant 2 was asked regarding error recovery through coping with it, the question: "Considering errors will be avoided if procedures are followed, how do you cope with it concerning the intensity of error committed?". Based on the informant's answer, the code assigned by the researchers is *momentary rest (as commonly advised by the supervisor)*. Informant 2 stated that following the investigation occurred in response to the error committed and if proven, the supervisor steps in and advises them to take a momentary rest for a week as a refresher. Informant 2 explains that recovery and healing need a fresh perspective, envisioning a journey that loops back on itself, bringing the person back to the center of freedom and the continual act of choosing anew. This approach to transforming time isn't a straightforward, clinical model found in many treatment programs; instead, it's a self-driven, cyclical way of experiencing time (Schalow, 2017). Elements of work schedules like short intervals between shifts, being called in on days off, and insufficient sleep between work periods are connected to higher levels of tiredness (Benzo, 2019).

Master Theme 3.4.2.2: Coping with error
Superordinate Theme 3.4.2.1.2: Learn
Informant 3: *... they gave wrong instruction and then miscoordination. They didn't communicate, then two aircrafts collided while on the ground. After deliberating, they are stripped of their license ...*

Informant 3 was asked the same question as Informant 2: "Considering errors will be avoided if procedures are followed, how do you cope with it with respect to the intensity of error committed?". The researchers assigned the code *learn* based on the informant's response to the question. Informant 3 stated that based on a past accident that happened to their colleagues where miscoordination occurred between two operators and later on was revoked and relieved from their work, it served as a learning experience for them as a coping strategy from errors. As stated by Dahlin et. al., (2018), learning from failure often means gaining insights from mistakes, both our own and those of others, which provide valuable information. Learning effectively from safety incidents involves considering specific factors and conditions associated with the organization, those involved in learning, the learning process, and the incidents (Stemn et al., 2018).

The variable situational awareness yielded three master themes and five superordinate themes upon data analysis.

Master Theme	Superordinate Themes
3.4.3.1.1 Importance of SA	3.4.3.1.1.1 Safety
3.4.3.1.2 Factors affecting SA	3.4.3.1.2.1 Distraction 3.4.3.1.2.2.Stress
3.4.3.1.3 Impact of High Pressure on SA	3.4.3.1.3.1 Exhaustion 3.4.3.1.3.2 Lax

Master Theme 3.4.3.1.1
Superordinate Theme 3.4.3.1.1.. Safety
Informant 1: Situational awareness is crucial because you need to know the position of aircraft in your airspace and identify the potential traffic.

Informant 1 was asked a question related to situational awareness, the question. "How is alertness important in the context of Air Traffic Controllers?". Based on the answer of Informant 1, the researchers assigned the code safety. The informant explained the importance of aircraft positioning and having good communication with the pilot in command to maintain the safety of each aircraft. Based on Steffen et al., (2019), aviation safety is the focus of most companies, which helps them know what to improve in their system, aircraft, or personnel. Statistics show a low rate of accidents; however, the

safety of every person is still challenging to improve. (Steffen et al., 2019) developed a system that measures safety levels called "Measuring Safety in Aviation-Developing Metrics for Safety Management Systems. Weick & Sutcliffe (2001) discussed safety as a "dynamic non-event" which explains that most people don't care about safety and the risk that might happen during the operation. As stated in ICAO (2013a, pgl1-2) safety is important based on the safety performance and performance target.

Master Theme 3.4.3.1.2: Factors affecting situational awareness

Superordinate Theme 3.4.3.1.2.1: Distraction

Informant 1: … sometimes, when on duty, people use their cellphones. That happens, right? So when your focus is taken away from your work, it can cause a sort of safety issue

Informant 1 was asked a question related to situational awareness, the question. "What usually affects your alertness?". Based on the answer of Informant 1, the researchers assigned the code distraction. The Informant explained that using mobile devices during their shift affects the alertness of the ATCOs and may cause aviation accidents if they lose their focus while monitoring each aircraft. Trapsilawat et al. (2020) addresses a notable gap in existing research by investigating the effects of air traffic conflict geometry on ATCOs, specifically examining their situational awareness, stress levels, and brain activity during conflict resolution. Trapsilawati et al. (2020) have extensively explored the impact of conflict geometry on pilots, the authors highlight the lack of research in the context of ATCOs, emphasizing the need for a comprehensive understanding of human factors in air traffic management. This review explores related literature, focusing on factors influencing situational awareness, stress, and distraction, with a particular emphasis on the ATCO perspective.

Master Theme 3.4.3.1.2: Factors affecting situational awareness

Superordinate Theme: 3.4.3.1.2.2: Stress

Informant 3: Same goes with us. When we consume our energy and eventually, we get exhausted and we still have to go to work, that is when it declines

Informant 3 was asked the question "What usually affects your alertness?". Based on the answer of Informant 3, the researchers assigned the code stress. The Informant explained that a long shift affects them, and makes them exhausted and stressed, which in turn causes their performance to decline due to the said reason. Informant 3 stated that long hours of shifts affect the mental and physical state of ATCOs which makes them vulnerable to committing error while facilitating and maintaining the safety of each aircraft. Munir et al., (2022) explained that situational awareness presents a comprehensive examination of the current challenges and prospects regarding the enhancement of situational awareness. The study of Munir. et al., (2022) on Philippine Air Traffic Control Operators (ATCOs) takes a human-centered approach, acknowledging the critical role played by individuals in decision-making processes within the aviation sector. Understanding how ATCOs process information, handle stress and make real-time decisions can contribute to the development of metrics and assessment tools tailored to the aviation domain. This aligns with the broader goal of enhancing SA for specific application domains, as emphasized in Munir et al.'s work.

Master Theme 3.4.3.1.3: impact of high pressure on situational awareness

Superordinate Theme: 3.4.3.1.3.1: Exhaustion

Informant 1: At my pace, I think…what is more stressful for me is when I have a lot of aircraft to handle because I become more focused on that.

Informant 1 was asked the question "How does a high-pressure situation affect your ability to maintain alertness?". Based on the answer of Informant 1, the researchers assigned the code exhaustion. The Informant explained that handling multiple aircraft at once requires focus to maintain the safety of the aircraft. In addition, the Informant focuses on maintaining efficient ATCOs and does not let their surroundings affect them because they know how important their task is. Kearney et al., (2019) elaborated that research provides crucial insights into the impact of high-pressure conditions, specifically fatigue, on ATCOs' alertness and, consequently, their situational awareness. ATCOs exhibit high levels of alertness during standard working hours, but a discernible decline is observed over the course of the working week. The 6th, 7th, and 8th working hours on day 4 and day 5 demonstrate significantly worsened alertness, indicating the cumulative effects of fatigue. This decline in alertness underscores the potential compromise of situational awareness under sustained high-pressure conditions.

Master Theme 3.4.3.1.3: impact of high pressure on situational awareness

Superordinate Theme 3.4.3.1.3.2: lax

Informant 2: … It is difficult to retain composure since there are lots of calls and aircrafts that are being handled, so for me, if you're in a hard situation then your composure breaks, that is when it affects your alertness. Because of pressure, your alertness is affected …

Informant 2 was asked a question related to situational awareness, the question. "How do high-pressure situations affect your ability to maintain alertness?". Based on the answer of Informant 2, the researchers assigned the code lax. The Informant explained that handling multiple calls and aircraft from different pilots makes them lose their focus. Once that happens they hardly recover from it because their composure is lost. The demanding nature of responsibilities requires unwavering attention, as each situation needs a right call from them. Based on the study of Friedrich. et al. (2018). A critical

aspect of ATCO performance is their interaction with the environment, particularly how task load influences their Situation Awareness (SA) and control strategies. Understanding the impact of high-pressure situations on SA is crucial for evaluating the quality of ATCO workplaces. Moreover, the study by Friedrich et al. (2018) explores how ATCOs adapt their control strategies under increased task load and pressure.

The variable Stress and coping strategies yield five themes and eleven superordinate themes upon data analysis.

Master Theme	Superordinate Themes
3..4.4.1 Identification of Stressor	3.4.4.1.1 Miscommunication 3.4.4.1.2 Lack of manpower 3.4.4.1.3 External
3.4.4.2 Impact of Stress	3.4.4.2.1 Performance decline
3.4.4.3 Coping Strategies	3.4.4.3.1 Procedures 3.4.4.3.2 Rest 3.4.4.3.3 Vacation
3.4.4.4 Organizational Efforts towards Stress Reduction	3.4.4.4.1 Breaks 3.4.4.4.2 Social Events
3.4.4.5 Program Impact on Stress Management	3.4.4.5.1 Increase cognitive capacity 3.4.4.5.2 Reduce stress

Master Theme 3.4.4.1 Stress and coping strategies
Superordinate Theme 3.4.4.1.1: Miscommunication
Informant 1: ... *Sometimes, it's due to miscommunication or misunderstanding between facilities or with pilots, so those are examples of the stress I encounter at work ...*

Informant 1 was asked a question related to stress and mitigation with the question "What are the common stressors you experience at work?". The researchers assigned the code *miscommunication* to the response of the informant. The Informant explained that miscommunication between colleagues and Pilots is one of the stressors for him at work. The Informant stated that he experienced stress in a situation where miscommunication with his co-workers and with Pilots. It is stated that miscommunication as a lack or poor when it comes to understanding of communication creates conflict which results in a stressor for the ones who experience miscommunication. Deep, et al. (2016). It is also stated that when it comes to the work environment, each personnel attains to meet the job satisfaction, although when miscommunication arises it tends to affect personnel's trust among colleagues which becomes a stressor for them as stated by Pradhan, et al. (2022).

Master Theme 3.4.4.1 Stress and coping strategies
Superordinate Theme 3.4.4.1.2: Lack of manpower
Informant 2: *For common stressors, with regards to work, our common stressors is usually the lack of manpower because as of now we need to work more than 40 hours a week to compensate for the lack of personnel.*

Informant 2 was asked a question related to stress and mitigation with the question "What are the common stressors you experience at work?". The researchers assigned the code *lack of manpower* to the response of the informant. The Informant explained that lack of manpower is a common stressor when it comes to the workplace. When it comes to manpower, they tend to overwork their personnel resulting in a stressor due to working overtime as stated by Moreto (2016). The Informant explained that when they lack manpower in the workplace, they need to work additional hours to compensate for the lack of manpower. It is stated that lack of manpower among personnel causes an inevitable result in occupational stress which affects their performance in meeting job satisfaction (Renukamurthy, 2017).

Master Theme 3.4.4.1 Stress and coping strategies
Superordinate Theme 3.4.4.1.3: External
Informant 3: *Usually, the environment is the stressor for me, like from going home and the traffic.*

Informant 3 was asked a question related to stress and mitigation with the question "What are the common stressors you experience at work?". The researchers assigned the code *external* to the response of the informant. The Informant explained that he usually experiences stress due to traffic when going back home from work. When it comes to workers, they tend to be stressed due to external experiences. External experiences of workers affect their well-being because of external or personal stress as stated by Cahill et al. (2020). It is also stated that for employees, external stress causes the inability to perform well within the workplace. The factor of external stress tends to affect their performance in the work environment which causes the inability to meet the overall job satisfaction of employees. (Slazyk-Sobol, 2021).

Master Theme 3.4.4.2 Stress and coping strategies
Superordinate Theme 3.4.4.2.1: Performance decline
Informant 2: *once it is stressed, your thinking time prolongs once in a situation in the field while in operations normally if there's a scenario, instead solving it let's say 5 seconds you end up thinking up to 10 to 15 those are the times when your ability to think declines*

Informant 2 was asked a question related to stress and mitigation with the follow-up question "How does it affect your performance?". The researchers assigned the code *performance decline* to the response of the informant. The Informant said that once he starts experiencing stress while at work, his thinking time starts to slow down resulting in inefficiency when it comes to decision-making. When it comes to the performance of personnel, prolonged shifts tend to result in experiencing job

stress which affects their performance to meet the job satisfaction as stated by Hanafi et al. (2018).

Master Theme 3.4.4.3 Stress and coping strategies
Superordinate Theme 3.4.4.3.1: following procedures
Informant 1: *... the training and strictly following the procedures. Because, you are a air traffic controller, once you've made decision, you need to stick to that decision. Don't change your mind, especially when you're managing traffic; if you've decided to prioritize a certain traffic flow for number one sequence, stick to that decision ...*

Informant 1 was asked a question related to stress and mitigation with the question "What are your strategies to cope with stress and improve your overall level of performance in the workplace?". The researchers assigned the code *following procedures* to the response of the informant. The informant said that when it comes to coping with stress, he follows the procedures to improve his overall performance while in the workplace. It is standard to base and comply with the standard operating procedures, personnel apply it to meet and maintain job satisfaction as stated by Yazgan et al. (2018).

Master Theme 3.4.4.3 Stress and coping strategies
Superordinate Theme 3.4.4.3.2: Rest
Informant 2: *I only take a rest and avoid going out once off duty, I spend time with family to lessen stress.*

Informant 2 was asked a question related to stress and mitigation with the question "What are your personal strategies to cope with stress and improve your overall level of performance in the workplace?". The researchers assigned the code *rest* to the response of the informant. The Informant said that he copes with stress and improves his overall performance by taking rest after work and avoiding unnecessary trips. When workers experience stress within the workplace, the strategy they use to recover is proper rest after working hours which results in retaining overall fitness to perform well again as stated by Caldwell et al. (2019).

Master Theme 3.4.4.3 Stress and coping strategies
Superordinate Theme 3.4.4.3.3: Vacation
Informant 3: . *To cope up, I sleep, and do the things I feel that I deserve, like eating or going somewhere. I married a fellow controller, I have four kids and two pets. So, we make sure that I have time for myself to recuperate from the stress of the job.*

Informant 3 was asked a question related to stress and mitigation with the question "What are your personal strategies to cope with stress and improve your overall level of performance in the workplace?". The researchers assigned the code *vacation* to the response of the informant. The Informant said that she copes with stress and improves her overall performance by going out to bond with family such as going out somewhere and eating something they like. Personnel consider vacation as a coping mechanism to relieve occupational stress, the personnel benefits from vacation resulting in the restoration of their well-being as it relieves them from the negative effects of a prolonged cycle of work as stated by Chen et al. (2017).

Master Theme 3.4.4.4 Stress and coping strategies
Superordinate Theme 3.4.4.4.1: Breaks
Informant 1: *there are studies suggesting that working for more than two hours as an Air Traffic Controller can cause a degradation in performance, so we have to take breaks. Our organization set a maximum of four hours for us to work.*

Informant 1 was asked a question related to stress and mitigation with the question "What does your organization do to reduce your stress levels?". The researchers assigned the code *breaks* to the response of the informant. The Informant said that the organization helps them to reduce stress levels by giving them sufficient hours of work shifts so they can have adequate breaks to mitigate stress. The break of workers in the workplace provides recovery of their well-being. The workers tend to recover from these effects when they take a break which makes time for them to compose themselves to be well-fit when coming back to work as stated by Hunter and Wu (2016).

Master Theme 3.4.4.4 Stress and coping strategies
Superordinate Theme 3.4.4.4.2: Social events
Informant 3: *We also have different activities like sports fest. There are ATC/Pilots. I also invited Capt. Alejandro to join us next week so we can tune in. We have other needs than financial, we need socialization. So, the organization tries to create a venue for the activities other than Manila. We also go to different places.*

Informant 3 was asked a question related to stress and mitigation with the question "What does your organization do to reduce your stress levels?". The researchers assigned the code *Social events* to the response of the informant. The Informant said that the organization helps them to mitigate stress by providing social events. The Informant stated that the organization creates venues where co-workers can gather and bond with each other through non-related work activities. When workers experience stress due to work, their organization comes up to reduce them by gathering workers to a social event which results in a positive bond with colleagues. It is effective in giving workers time to latch out their stress due to work. This results in workers attaining positive behavior that strengthens their organizational purpose knowing their organization helps them reduce their stress as stated by Syayyidah (2017).

Master Theme 3.4.4.5 Stress and coping strategies
Superordinate Theme 3.4.4.5.1: Increase cognitive capacity
Informant 1: *I think it's effective for me, and it's okay. We also have more time to relax or take breaks because we were*

given a maximum of only four hours to work per shift. So it's effective for me. Even then, our performance is not compromised because we are given a long break, you know. So I think for me, it's effective.

Informant 1 was asked a question related to stress and mitigation with the question "How do you think these programs directly affect stress management in your workplace?". The researchers assigned the code to *increase cognitive capacity* to the response of the informant. The Informant said that sufficient break time given positively impacts their stress management. The effectiveness of break time for the informant gives resiliency when it comes to performance. Strategies are made for workers to reduce job stress, it provides sufficient time to prepare themselves when coming back to work as stated by Shariatkhah (2017).

Master Theme 3.4.4.5 Stress and coping strategies
Superordinate Theme 3.4.4.5.2: Reduce stress
Informant 2: *The least stress in the facility, we are able to divide it with our colleagues so you're not the only one who is stressed but also co-controllers. You're not the only one that's stressed because the stress is being divided within your colleagues.*

Informant 2 was asked a question related to stress and mitigation with the question "How do you think these programs directly affect stress management in your workplace?". The researchers assigned the code to *reduce stress* on the response of the Informant. The Informant said that at least the stress they experience in the facility is delegated to every personnel within the workplace, resulting in reduction of stress level they can experience. Organizations manage to create ways in helping personnel to cope with job stress such as proper delegation of work and sharing of assigned tasks with co-workers as stated by Panigrahi (2017).

4. Discussion

A. Conclusions

Based on the results and analysis, the following were concluded:

- This study shows no significant difference between ATCOs with 0-9 and 10-20 years of experience in terms of Cognitive state and resilience. Hence, the respondents' evaluation of cognitive state and resiliency are the same regardless of how long they have been in the organization. On the other hand, there is a significant difference in the respondents' decision-making. In particular, those ATCOs who have been in the institution between 10 and 20 years scored higher in decision-making, based on the effect size.
- Furthermore, the investigation shows that there is no significant relationship between cognitive state and resiliency; Resiliency and Decision-making capability, and; Decision-making Capability and Cognitive State.
- The organizational strategy and monitoring parameters of PATCA to ensure highly competent ATCO in terms of decision-making are outlined in Document 4444 (Standard Operating Procedures). Hence, a commitment to self-evaluation is headed to sustain a heightened level of decision-making capability. Decisions arising from deviations are subject to the severity of the situation, highlighting the importance of effective communication when gauging the trajectory of decisions to be made. Furthermore, the display of different perspectives during discussions on protocols for handling high-risk situations requires meticulous deliberation of decisions that should be suitable under the circumstances, referring to the procedural handbook. On the other hand, the resilience of an ATCO is founded on training. Personal challenges, notably the impact of the COVID-19 pandemic and the loss of an immediate family member, have been identified as significant events that demonstrated and enhanced resiliency. Furthermore, the organization conducts socialization-focused activities and offers continuous training to strengthen the resilience of ATCOs. This multifaceted approach contributes to the gradual and sustained strengthening of resilience over time.
- The results of the investigation indicated psychological variables affecting the resilience and decision-making of ATCOs. This includes; (a) cognitive decline, (b) attention decline, (c) error recovery, (d) situational awareness, and (e) stress and its mitigation.
    a. To elaborate concerning cognitive decline, this study revealed that factors contributing to cognitive decline included aging and longer periods of duty; to this physical fatigue and pressure they acquire during high volume of traffic were identified. To address cognitive decline, ATCOs employ strategies such as prioritizing tasks, ensuring sufficient rest, and engaging in physical exercise to attain a balanced lifestyle.
    b. Furthermore, the ability of an ATCO to make competent decisions and be resilient in operational conditions is impacted by the decline in attention. Researchers identified factors that contribute to an ATCO's attention decline, including high traffic volume and shift work hours. However, accumulated experience is what builds resistance to attention reduction.
    c. Moreover, error recovery is a critical procedure that affects how effective an

ATCOs can make decisions and be resilient. The study shows that ATCOs take over from a colleague and carry out an investigation to correct problems in response to procedural deficiencies. ATCOs are advised to implement lessons from their errors to handle such circumstances. When significant errors are made, accountable ATCOs are urged by their superiors to take a brief break from their duties in an attempt to regain their resilience and ability to make sound decisions.

d. When it comes to safety, an ATCO needs to be situationally aware to make systematic judgments and show resilience in an array of situations. Distraction, stress, and high-pressure circumstances are a few depictions of factors that may affect resilience. These conditions can also lead to fatigue and a possible loss in the effectiveness of decision-making.

e. Lastly, stress has significant implications on an ATCO decision-making ability and resilience. This research has identified miscommunication and manpower shortages as primary stressors during operations, leading to an overall decline in performance, and affecting both decision-making and resilience. ATCOs manage care of their stress levels by following procedures, obtaining enough sleep, and scheduling vacation time. The organization's approach to alleviating stress involves providing breaks and organizing social events, consequently enhancing cognitive capacity, reducing stress levels, and improving decision-making capabilities.

B. Recommendations

Based on the discussed conclusions, the recommendations are as follows:

- Air Transportation and Aviation Students in general must sharpen strong decision-making skills during their undergraduate studies. While cognitive state and resilience when they work will be strengthened in their future professional endeavors in the field.
- Future researchers may further explore the underlying factors in the Philippine setup in terms of ATCO to the variables used in the study.
- PATCA may utilize the results of this study to improve the performance of Philippine Air Traffic Control Officers. The study's conclusions can be used as a starting point for creating strategies to cope with the issues that prevent them from reaching their full potential, which will contribute to their ability to maximize their potential.
- Philippine ATCOs should understand the potential of using resilience and decision-making capability in terms of operation and its importance.
- In the case of replication of the study the researchers recommend utilizing physiological reports to strengthen the responses found in the psychological assessment done by the respondents. Furthermore, respondents of the study should have the following parameters
    a. Focusing on a certain gender either entirely male or entirely female ATCOs
    b. Focusing on one area of operations, either approach control only, tower control only, or en-route control only
    c. Researchers should gather respondents from the same geographic location to ensure uniformity of results.

References

[1]. Abd-Elfattah, H. M., Abdelazeim, F. H., & Elshennawy, S. (2015). Physical and cognitive consequences of fatigue: A review. In Journal of Advanced Research (Vol. 6, Issue 3).

[2]. Ahmad, R., & Anthony, S. W. (2021). The Decision-Making Practices among Air Traffic Controllers during Conflict Resolution in Aviation Industry: A Case Study. Journal of Cognitive Sciences and Human Development, 7(2), 66–79.

[3]. Aricò, P., et al. (2017). Human Factors and Neurophysiological Metrics in Air Traffic Control: A Critical Review. In IEEE Reviews in Biomedical Engineering (Vol. 10, pp. 250–263). Institute of Electrical and Electronics Engineers.

[4]. A passive brain–computer interface application for the mental workload assessment on professional air traffic controllers during realistic air traffic control tasks. Progress in Brain Research, 228, 295-328.

[5]. Arnaldo, R.M. et al. (2018). Computerized Brain Interfaces for Adaptive Learning and Assessment. In: Karwowski, W., Ahram, T. (eds) Intelligent Human Systems Integration. IHSI 2018.Advances in Intelligent Systems and Computing, vol 722. Springer, Cham.

[6]. Barrett, J. D., et al. (2020). Stress Management and Air Traffic Control Trainees: Development and Evaluation of a New Training Course. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 64(1).

[7]. Benzo, R. (2019). The Effects of Shift Type and Consecutive Shifts on U.S. Hospital Nurses' Occupational Patterns of Physical Activity, Sedentary Behavior, and Momentary Fatigue. ProQuest.

[8]. Bernhardt, K. A., et al. (2019). The effects of dynamic workload and experience on commercially available EEG cognitive state metrics in a high-fidelity air traffic control environment. Applied Ergonomics, 77, 83–91.

[9]. Bongo, M. F., et al.. (2018). An application of DEMATEL-ANP and PROMETHEE II approach for air traffic controllers' workload stress problem: A case of Mactan Civil

Aviation Authority of the Philippines. Journal of Air Transport Management, 68.

[10]. Bongo, M., & Seva, R. (2021). Effect of Fatigue in Air Traffic Controllers' Workload, Situation Awareness, and Control Strategy. International Journal of Aerospace Psychology, 32(1), 1–23.

[11]. Borghini, G., et al. (2020). A multimodal and signals fusion approach for assessing the impact of stressful events on Air Traffic Controllers. Scientific Reports.

[12]. Brady, L., Harms, P., Wood D., & Silard A.(2018). Resilience and well-being. Handbook of Well-Being. UT: DEF Publishers. p. 1–12.

[13]. Cahill, J., et al. (2020). The Requirements for New Tools for Use by Pilots and the Aviation Industry to Manage Risks Pertaining to Work-Related Stress (WRS) and Wellbeing, and the Ensuing Impact on Performance and Safety. Technologies, 8(3).

[14]. Cairney, J., et al. (2014). Who uses exercise as a coping strategy for stress? Results from a National Survey of Canadians. Journal of Physical Activity and Health, 11(5).

[15]. Caldwell, J. A., et al. (2019). Fatigue and its management in the workplace. Neuroscience and Biobehavioral Reviews (Vol. 96, pp. 272–289). Elsevier Ltd.

[16]. Callari, T. C., et al. (2019). Investigating and operationalising the mindful organising construct in an Air Traffic Control organisation. Safety Science, 120, 838–849.

[17]. Caporale, A., et al. (2022). Assessing the impact of environmental quality factors on the industrial performance of aged workers: A literature review. In Safety Science (Vol. 149). Elsevier B.V.

[18]. Casey, T. W., & Krauss, A. D. (2013). The role of effective error management practices in increasing miners' safety performance. Safety Science, 60, 131–141.

[19]. Cekanova, A., et al. (2018). Fatigue and Stress Factors Among Aviation Personnel. Acta Avionica. Volume XX, 39 – No. 2.

[20]. Chang, D., et al. (2019). A user-centric smart product-service system development approach: A case study on medication management for the elderly. Advanced Engineering Informatics, 42.

[21]. Chang, Y.-H., Yang, H.-H., & Hsu, W.-J. (2019). Effects of work shifts on fatigue levels of air traffic controllers. Journal of Air Transport Management, 76, 1–9.

[22]. Chen, C.-C., et al. (2017). How does taking a vacation help relieve your work stress?

[23]. Chisholm, D. (2016). Investing in global mental health: The time for action is now. The Lancet Psychiatry, 3(5), 390–391.

[24]. Cigularov, K. P., Chen, P. Y., & Stallones, L. (2009). Error communication in young farm workers: Its relationship to safety climate and safety locus of control. Work & Stress, 23(4), 297–312.

[25]. Colakkadioglu, O., & Celik, D. B. (2016). The Effect of Decision-Making Skill Training Programs on Self-Esteem and Decision-Making Styles. Eurasian Journal of Educational Research, 16(65).

[26]. Coombs, C., et al. (2020). The strategic impacts of Intelligent Automation for knowledge and service work: An interdisciplinary review. The Journal of Strategic Information Systems, 101600.

[27]. Cosic, K., et al. (2019). New Tools and Methods in Selection of Air Traffic Controllers Based on Multimodal Psychophysiological Measurements. IEEE Access, 1–1.

[28]. Stress Resilience Assessment Based on Physiological Features in Selection of Air Traffic Controllers. IEEE Access, 1–1.

[29]. Costa, G. (1996). Occupational Stress and Stress Prevention in Air Traffic Control. Office (p. 43).

[30]. Dahlin, K., Chuang, Y. & Roulet, T. (2018). Opportunity, Motivation, and Ability to Learn from Failures and Errors: Review, Synthesis, and Ways to Move Forward. Academy of Management Annals.

[31]. Deary, I. J., et al. (2009). Age-associated cognitive decline. British Medical Bulletin, 92(1), 135–152.

[32]. Deep, S., Othman, H., & Salleh, B. M. (2016). Potential Causes and Outcomes of Communication Conflicts at the Workplace -A Qualitative Study in Pakistan. Journal of Management Info, 3(3), 1–5.

[33]. Di Flumeri, G., et al. (2015). On the Use of Cognitive Neurometric Indexes in Aeronautic and Air Traffic Management Environments. Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 9359, 45–56.

[34]. Brain–Computer Interface-Based Adaptive Automation to Prevent Out-Of-The-Loop Phenomenon in Air Traffic Controllers Dealing With Highly Automated Systems. Frontiers in Human Neuroscience, 13, 469230.

[35]. Dobrowolska, M., et al. (2020). Strengthening Professional Efficacy Due to Sustainable Development of Social and Individual Competences—Empirical Research Study among Polish and Slovak Employees of the Aviation Sector. Sustainability, 12(17), 6843.

[36]. Dominguez-Cancino, K., et al. (2022). Psychometric Properties of the Connor-Davidson

[37]. Resilience Scale for South America (CD-RISC-25SA) in Peruvian Adolescents. Children.

[38]. Dong SUI, Weiping XU, Kai ZHANG, (2022). Study on the resolution of multi-aircraft flight conflicts based on an IDQN, Chinese Journal of Aeronautics,Volume 35, Issue 2, Pages 195-213.

[39]. Donmez, K., et al. (2022). Service Quality and Efficiency-Oriented Training Design in Air Traffic Management. Transportation Research Procedia, 64(C).

[40]. Dragan, P; Zeljko, S; Sinisa, S. (2018). A new model for determining weight coefficient of criteria in MCDM models: Full consistency method (FUCOM). Symmetry 10(9), 393.

[41]. E, X., & Zhang, J. (2017). Holistic thinking and air traffic controllers' decision making in conflict resolution. Transportation Research Part F: Traffic Psychology and Behaviour, 45, 110–121.

[42]. Evans, A., Vaze, V., & Barnhart, C. (2016). Airline-driven performance-based air traffic management: Game theoretic models and multicriteria evaluation. Transportation Science, 50(1), 180–203.
[43]. Falkland, E. C., & Wiggins, M. W. (2019). Cross-task cue utilization and situational awareness in simulated air traffic control. Applied Ergonomics, 74, 24–30.
[44]. Freire, C., F. et al. (2020). Coping Strategies and Self-Efficacy in University Students: A Person-Centered Approach. Frontiers in Psychology, 11.
[45]. French, S. & Steel, T. (2017). The Investigation of Safety Management Systems Safety Culture. International Transport Forum.
[46]. Friedrich, M., Biermann, M., Gontar, P., Biella, M., & Bengler, K. (2018). The influence of task load on situation awareness and control strategy in the ATC tower environment. Cognition, Technology & Work, 20(2), 205–217.
[47]. García-Izquierdo, M., et al. (2018). The moderating role of resilience in the relationship between academic burnout and the perception of psychological health in nursing students. Educational Psychology, 38(8), 1068–1079.
[48]. Gomez Comendador, V. F., et al. (2018). Impact of Trajectories' Uncertainty in Existing ATC Complexity Methodologies and Metrics for DAC and FCA SESAR Concepts. Energies, 12(8), 1559.
[49]. Grace, K., et al. (2018). Viewpoint: When Will AI Exceed Human Performance? Evidence from AI Experts. Journal of Artificial Intelligence Research, 62, 729–754.
[50]. Gutiérrez Teuler, G., et al. (2022). Study of the Impact of Traffic Flows on the ATC Actions.
[51]. Hanafi, A., Zunaidah, -, & Ulfa, M. (2018). The Effect of Job Stress Toward Employee Performance Through Job Satisfaction of PT Muara Alam Sejahtera Employees. International Journal of Scientific and Research Publications (IJSRP), 8(8).
[52]. Heath C., Sommerfield A., & Ungern-Sternberg B. (2020). Resilience strategies to manage psychological distress among healthcare workers during the COVID-19 pandemic: a narrative review. Anaesthesia. 75:1364–71.
[53]. Hedayati, S., et al. (2021). Evaluating differences in cognitive functions and personality traits among air traffic controllers with and without error history. Safety Science, 139.
[54]. Hoskova-Mayerova, S., et al. (2022). Development of a Methodology for Assessing Workload within the Air Traffic Control Environment in the Czech Republic. Sustainability (Switzerland), 14(13).
[55]. Howells, K., Sarkar., M & Fletcher, D. (2017). Can athletes benefit from difficulty? A systematic review of growth following adversity in competitive sport. Progress in Brain Research. 234. 117-159.
[56]. Hunter, E. M., & Wu, C. (2016). Give me a Better break: Choosing workday break activities to maximize resource recovery. Journal of Applied Psychology, 101(2), 302–311.
[57]. Hyde, J. S. (2016). Sex and cognition: gender and cognitive functions. Current Opinion in Neurobiology, 38, 53–56.
[58]. Iqbal, M., & Waseem, M. A. (2017). Impact of Job Stress on Job Satisfaction among Air Traffic Controllers of Civil Aviation Authority: An Empirical Study from Pakistan. International Journal of Human Resource Studies, 2(2), 53.
[59]. Jaiswal, K., et al. (2019). Aviation MRO: A Case Study Of Social Psychology Elements Of Human Factor Affecting Work Performance. 2019 Advances in Science and Engineering Technology International Conferences (ASET).
[60]. James, L., et al. (2020). Sleep health and predicted cognitive effectiveness of nurses working 12-hour shifts: an observational study. International Journal of Nursing Studies, 112.
[61]. Jankovics, I., et al. (2017). Developing ATCOs 'Support System: Load Management, Integrated Sensors and Eye Tracking. Scientific Cooperations International Journal of Mechanical and Aerospace Engineering, 3(1), 25-42.
[62]. Ng, K. K. H., et al. (2020). A two-stage robust optimisation for terminal traffic flow problem. Applied Soft Computing, 89.
[63]. Kalisch, R., et al. (2017). The resilience framework as a strategy to combat stress-related disorders. In Nature Human Behaviour (Vol. 1, Issue 11).
[64]. Kaliyaperumal, D., et al. (2017). Effects of sleep deprivation on the cognitive performance of nurses working in shift. Journal of Clinical and Diagnostic Research, 11(8).
[65]. Kam, K.H. et al. (2021). Mathematical programming formulations for robust airside terminal traffic flow optimisation problem, Computers & Industrial Engineering, Volume 154.
[66]. Karabushchenko, N. B., Pilishvili, T. S., & Sungurova, N. L. (2019). Features of stress resistant personality of dispatchers, air traffic controllers and registration agents in the airport system.
[67]. Karikawa, D. Kitamura, M. (2020). Resilience of Air Traffic Controllers in control tower. Linnaeus University.
[68]. Kaspers, S., et al. (2019). How does aviation industry measure safety performance? Current practice and limitations. International Journal of Aviation Management, 4(3), 224.
[69]. Kearney, P., Li, W. C., & Braithwaite, G. (2019). Roster and Air Traffic Controller's Situation Awareness. Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 11571 LNAI, 66–75.
[70]. Kelly, D., & Efthymiou, M. (2019). An analysis of human factors in fifty controlled flights into terrain aviation accidents from 2007 to 2017. Journal of Safety Research, 69, 155–165.
[71]. Kim, E.Y. & Chang, S.O. (2022). Exploring nurse perceptions and experiences of resilience: a meta-synthesis study. BMC Nurs 21, 26.
[72]. Kim, G., Let al. (2018). Resilience of patients with chronic diseases: A systematic review. Health and Social Care in the Community.

[73]. Khaldi, K. (2017). Quantitative, Qualitative or Mixed Research: Which Research Paradigm to Use? Journal of Educational and Social Research, 7(2), 15–24.
[74]. Koninck, N. (2017). Reaching out to the next generation: Student air traffic controller selection & Training process, Madrid, Spain.
[75]. Konstantinidis, E., & Shanks, D. R. (2014). Don't bet on it! Wagering as a measure of awareness in decision making under uncertainty. Journal of Experimental Psychology: General, 143(6), 2111–2134.
[76]. Labrague, L., & De Los Santos, J. (2021). Prevalence and predictors of coronaphobia among frontline hospital and public health nurses. Public Health Nursing.
[77]. Langan-Fox, J., Sankey, M. J., & Canty, J. M. (2009). Human Factors Measurement for Future Air Traffic Control Systems. Human Factors: The Journal of the Human Factors and Ergonomics Society, 51(5), 595–637.
[78]. Langer, Á. I., et al. (2017). The effect of a mindfulness-based intervention in cognitive functions and psychological well-being applied as an early intervention in schizophrenia and high-risk mental state in a Chilean sample: Study protocol for a randomized controlled trial. Trials, 18(1).
[79]. Lee, C., et al. (2019). Smart robotic mobile fulfillment system with dynamic conflict-free strategies considering cyber-physical integration. Advanced Engineering Informatics, 42, 100998.
[80]. Lee, C. K. M., et al. (2018). A multi-group analysis of social media engagement and loyalty constructs between full-service and low-cost carriers in Hong Kong. Journal of Air Transport Management, 73, 46–57.
[81]. Li, F., et al. (2020). An explorative context-aware machine learning approach to reducing human fatigue risk of traffic control operators. Safety Science.
[82]. Li, Q., et al. (2021). A human-centred approach based on functional near-infrared spectroscopy for adaptive decision-making in the air traffic control environment: A case study. Advanced Engineering Informatics, 49, 101325.
[83]. Li, W. C., Zhang, J., & Kearney, P. (2023). Psychophysiological coherence training to moderate air traffic controllers' fatigue on rotating roster. Risk Analysis, 43(2).
[84]. Lin, N., Ensel, W. M., & Vaughn, J. C. (2019). Social resources and strength of ties: Structural factors in occupational status attainment. Social Capital, Social Support and Stratification: An Analysis of the Sociology of Nan Lin (pp. 37–49).
[85]. Loree J., et al. (2019). Disparity of Race Reporting and Representation in Clinical Trials Leading to Cancer Drug Approvals From 2008 to 2018. JAMA Oncol.5(10).
[86]. Lou, S., et al. (2020). An integrated decision-making method for product design scheme evaluation based on cloud model and EEG data. Advanced Engineering Informatics, 43.
[87]. Lyu, T., Song, W., & Du, K. (2018). Human Factors Analysis of Air Traffic Safety Based on HFACS-BN Model. Applied Sciences, 9(23), 5049.
[88]. Majid, S., et al. (2022). The effect of safety risk management and airport personnel competency on aviation safety performance. Uncertain Supply Chain Management.
[89]. Makara-Studzińska, M., et al. (2021). An exploration of perceived stress, burnout syndrome, and self-efficacy in a group of Polish air traffic controllers and maritime navigators: Similarities and differences. International Journal of Environmental Research and Public Health, 18(1), 1–16.
[90]. Malakis, S., et al. (2019). Classification of air traffic control scenarios using decision trees: insights from a field study in terminal approach radar environment. Cognition, Technology & Work.
[91]. Manjunatha, M K. & Renukamurthy, T. P. (2017). STRESS AMONG BANKING EMPLOYEE- A LITERATURE REVIEW. International Journal of Research - GRANTHAALAYAH, 5(1) 206–213.
[92]. Marinakou, E. (2022). Post-Pandemic Factors Influencing Job Satisfaction Among Airline Crew: A comparative study of a UK and Portuguese airline. Type of Submission: Paper.
[93]. Massar, S. A. A., et al. (2016). Rewards boost sustained attention through higher effort: A value-based decision making approach. Biological Psychology, 120, 21–27.
[94]. Masten, AS & Barnes, AJ. (2018) Resilience in children: developmental perspectives. Children.
[95]. Mechera-Ostrovsky, T., et al. (2022). Cognitive abilities affect decision errors but not risk preferences: A meta-analysis. Psychonomic Bulletin and Review. Springer.
[96]. Mijić, M. Šarlija & D. Petrinović, (2019). MMOD-COG: A Database for Multimodal Cognitive Load Classification. 2019 11th International Symposium on Image and Signal Processing and Analysis (ISPA), Dubrovnik, Croatia, pp. 15-20.
[97]. Moreto, W. D. (2016). Occupational stress among law enforcement rangers: Insights from Uganda. ORYX, 50(4), 646–654.
[98]. Mouratille, D., Amadieu, F., & Matton, N. (2022). A meta-analysis on air traffic controllers' selection: cognitive and non-cognitive predictors: Meta-analysis on ATCO selection. Journal of Vocational Behavior, 138.
[99]. Muir, H.C., & Harris, D. (2017). Contemporary Issues in Human Factors and Aviation Safety (1st ed.). Routledge.
[100]. Munir, A., Aved, A., & Blasch, E. (2022). Situational Awareness: Techniques, Challenges, and Prospects. AI, 3(1), 55–77.
[101]. Murman, D. L. (2015). The Impact of Age on Cognition. Seminars in Hearing, 36(3).
[102]. Nasseef, O. A., et al. (2021). Artificial intelligence-based public healthcare systems: G2G knowledge-based exchange to enhance the decision-making process. Government Information Quarterly, 101618.
[103]. Newman, D. T., Fast, N. J., & Harmon, D. J. (2020). When eliminating bias isn't fair: Algorithmic reductionism and procedural justice in human resource decisions. Organizational Behavior and Human Decision Processes, 160, 149–167.

[104]. Ng, K., et al. (2017). Robust aircraft sequencing and scheduling problem with arrival/departure delay using the min-max regret approach. Transportation Research Part E: Logistics and Transportation Review, 106, 115-136.
[105]. Ng, K., et al. (2020). A Digital Twin-Based Platform towards Intelligent Automation with Virtual Counterparts of Flight and Air Traffic Control Operations. Applied Science.
[106]. Nunes, A., & Kramer, A. F. (2009). Experience-based mitigation of age-related performance declines: Evidence from air traffic control. Journal of Experimental Psychology: Applied, 15(1), 12–24.
[107]. Odu, G. O. (2019). Weighting methods for multi-criteria decision-making technique. Journal of Applied Sciences and Environmental Management, 23(8), 1449.
[108]. O'Hagan, A. D.,et al. (2020). "Flying on empty"–effects of sleep deprivation on pilot performance. Biological Rhythm Research, 51(7).
[109]. Pagnotta, M., et al. (2022). Task difficulty and physiological measures of mental workload in air traffic control: a scoping review. Ergonomics. Taylor and Francis Ltd.
[110]. Palma Fraga, R., Reddy, P., Kang, Z., & Izzetoglu, K. (2020). Multimodal Analysis Using Neuroimaging and Eye Movements to Assess Cognitive Workload. In: Schmorrow, D.D., Fidopiastis, C.M. (eds) Augmented Cognition. Theoretical and Technological Approaches. HCII 2020. Lecture Notes in Computer Science, vol 12196. Springer, Cham.
[111]. Pang, Y., et al. (2023). Air traffic controller workload level prediction using conformalized dynamical graph learning. Advanced Engineering Informatics, 57, 102113.
[112]. Panigrahi, A. (2017). Managing stress at workplace. Journal of Management Research and Analysis, 3(4), 154–160.
[113]. Park, S., Lee, J. H., & Lee, W. (2019). The Effects of Workplace Rest Breaks on Health Problems Related to Long Working Hours and Shift Work among Male Apartment Janitors in Korea. Safety and Health at Work, 10(4), 512–517.
[114]. Paton, D. (2019). Disaster risk reduction: Psychological perspectives on preparedness. Australian Journal of Psychology, 71(4).
[115]. Pomytkina, L., et al. (2021). Environmental and emotional predictors of cognitive styles of air traffic controllers. E3S Web of Conferences, 258.
[116]. Porcelli, A. J., & Delgado, M. R. (2017). Stress and decision making: effects on valuation, learning, and risk-taking. In Current Opinion in Behavioral Sciences (Vol. 14).
[117]. Pradhan, C., Khaja, K., & Shaikh, M. (2022). Conflict at workplace. Indian Journal of Social Science and Literature Studies, 8(1).
[118]. Qinbiao L. et al. (2021). A human-centred approach based on functional near-infrared spectroscopy for adaptive decision-making in the air traffic control environment: A case study, Advanced Engineering Informatics,Volume 49.
[119]. Republic of the Philippines. Civil Aviation Authority of the Philippines. PHILIPPINE CIVIL AVIATION REGULATIONS (PCAR) PART 2 PERSONNEL LICENSING. (2023.).
[120]. Republic of the Philippines. Civil Aviation Authority of the Philippines. Aeromedical Advisory. (2020).
[121]. Restuputri, D., Fatimah, S., & Mubin, A. (2022). Air traffic control work system design to improve operator performance with workload approach and safety concept. Jurnal Sistem Dan Manajemen Industri, 6(2), 200–214.
[122]. Reva, O. M., et al. v. (2020). Quantitative indicators of air traffic controllers' attitude to the danger of errors. Science, Technologies, Innovation, 4(16), 68–78.
[123]. Rieckert, A., et al. (2021). How can we build and maintain the resilience of our health care professionals during COVID-19? Recommendations based on a scoping review. BMJ Open. BMJ Publishing Group.
[124]. Rognin, L., & Blanquart, J. P. (2021). Human communication, mutual awareness and system dependability. Lessons learnt from air-traffic control field studies. Reliability Engineering and System Safety, 71(3), 327–336.
[125]. Rohacs, D., Rohacs, J., & Jankovics, I. (2016). Conceptual development of an advanced air traffic controller workstation based on objective workload monitoring and augmented reality. Proceedings of the Institution of Mechanical Engineers (Part G: Journal of Aerospace Engineering Vol. 230), 1747 - 1761.
[126]. Ruihua, X, Fan, L (2022). Research on simulation of risk control strategy for air traffic controllers' unsafe acts. Safety Science.
[127]. Ruskin, K., et al. (2021). Alarms, alerts, and warnings in air traffic control: An analysis of reports from the Aviation Safety Reporting System. Transportation Research Interdisciplinary Perspectives.
[128]. Saleh, L. M., Ret al. (2022). The Development of a Work Stress Model for Air Traffic Controllers in Indonesia. Kesmas, 17(1), 40–47.
[129]. Salfi, F., et al. (2020). Effects of total and partial sleep deprivation on reflection impulsivity and risk-taking in deliberative decision-making. Nature and Science of Sleep, 12.
[130]. Sarlija, M., et al. (2021). Prediction of Task Performance from Physiological Features of Stress Resilience. IEEE Journal of Biomedical and Health Informatics.
[131]. Sartzetaki, M., et al. (2019). Interventions for Occupational Stress Management in Air Traffic Providers. Journal of Social and Political Sciences, 2(4).
[132]. Schalow, F. (2017). From Excess to Economy: The Elements of Recovery. Toward a Phenomenology of Addiction: Embodiment, Technology, Transcendence pp 161–177.
[133]. Serrano, F & Kazda, A. (2020). The future of airport post COVID - 19. Journal of Air Transport Management, 89.
[134]. Shariatkhah, J., Farajzadeh, Z., & Khazaee, K. (2017). The Effects of Cognitive-Behavioral Stress Management on

Nurses' Job Stress. Iranian Journal of Nursing and Midwifery Research 22(5), 394-402.

[135]. Sharon-David, H., & Tenenbaum, G. (2017). The Effectiveness of Exercise Interventions on Coping with Stress: Research Synthesis. Studies in Sport Humanities, 22.

[136]. Shneiderman, B. (2020). Human-Centered Artificial Intelligence: Reliable, Safe & Trustworthy. International Journal of Human–Computer Interaction, 36(6), 495–504.

[137]. Skagerlund, K., et al. (2021). Decision-making competence and cognitive abilities: Which abilities matter? Journal of Behavioral Decision Making, 35(1).

[138]. Slazyk-Sobol, M., et al. (2021). Stress And Self-Efficacy as Specific Predictors of Safety at Work in The Aviation Sector. Medycyna Pracy, 72(5), 479.

[139]. Socha, V., et al. (2020). Workload assessment of air traffic controllers. Transportation Research Procedia, 51, 243–251.

[140]. Sölva, K., Haselgruber, A. & Lueger-Schuster, B. (2023). Resilience in the face of adversity: classes of positive adaptation in trauma-exposed children and adolescents in residential care. BMC Psychol 11, 30.

[141]. Steffen, K., et al. (2019). How does aviation industry measure safety performance Current practice and limitations. International Journal of Aviation Management.

[142]. Stemn, E., et al. (2018). Failure to learn from safety incidents: Status, challenges and opportunities. Safety Science, 101, 313–325.

[143]. Stratton, S. (2021). Population Research: Convenience Sampling Strategies. PubMed.

[144]. Suárez, M. Z., et al. (2022). How much workload is workload? A human neurophysiological and affective - cognitive performance measurement methodology for air traffic controllers. IOP Conference Series: Materials Science and Engineering, 1226(1), 012085.

[145]. Subedi, D. (2016). Explanatory Sequential Mixed Method Design as the Third Research Community of Knowledge Claim. American Journal of Educational Research, Vol. 4, 2016, Pages 570-577.

[146]. Svensson, Å., Ohlander, U., & Lundberg, J. (2020). Design implications for teamwork in ATC. Cognition, Technology and Work, 22(2), 409–426.

[147]. Syayyidah and Claudius (2017). The Impact of Workplace Spirituality on Organizational Citizenship Behavior: The Roles of Organizational Identification and Perceived Organizational Supports. Asia Pacific Journal of Advanced Business and Social Studies, 3(2).

[148]. Szakács, Z. et.al (2022). A többműszakos munkavégzés biztonsági kihívásai a rend- és honvédelmi szerveknél. Scientia et Securitas, 3(1), 19–30.

[149]. Tabibnia, G. (2020). An affective neuroscience model of boosting resilience in adults. Neuroscience and Biobehavioral Reviews. Elsevier Ltd.

[150]. Takács, R., et al. (2021). Exploring Coping Strategies of Different Generations of Students Starting University. Frontiers in Psychology, 12.

[151]. Timotic, D., & Netjasov, F. (2021). Automation in Air Traffic Control: Trust, Teamwork, Resilience, Safety. Transportation Research Procedia, 65, 13-23.

[152]. Toumasis, N. (2023). The role of Human Resource Management in preventing Occupational Stress in Air Traffic Controllers in the European Union. International Journal of Novel Research in Humanity and Social Sciences, 10(22).

[153]. Tourunen, A., et al. (2019). Psychometric properties of the 10-item Connor–Davidson resilience scale among Finnish older adults. Aging & Mental Health, 1–8.

[154]. Trapsilawati, F., et al. (2020). EEG-Based Analysis of Air Traffic Conflict: Investigating Controllers' Situation Awareness, Stress Level and Brain Activity during Conflict Resolution. The Journal of Navigation, 73(3), 678-696.

[155]. Trapsilawati, F., et al. (2015). Human factors assessment of conflict resolution aid reliability and time pressure in future air traffic control. Ergonomics, 58(6), 897–908.

[156]. Truschzinski, M., et al. (2018). Emotional and cognitive influences in air traffic controller tasks: An investigation using a virtual environment? Applied Ergonomics.

[157]. Van Cutsem, J., et al. (2017). The Effects of Mental Fatigue on Physical Performance: A Systematic Review. In Sports Medicine (Vol. 47, Issue 8).

[158]. van Woerkom M., Meyers M., Bakker A. (2020). Considering strengths use in organizations as a multilevel construct. Human Resource Management Review.

[159]. Vlašić, I., Đurasević, M., & Jakobović, D. (2019). Improving genetic algorithm performance by population initialisation with dispatching rules. Computers & Industrial Engineering, 137, 106030.

[160]. Vukovic, M., Stolar, M., & Lech, M. (2021). Cognitive Load Estimation From Speech Commands to Simulated Aircraft. IEEE/ACM Transactions on Audio Speech and Language Processing, vol. 29, pp. 1011-1022.

[161]. Walsh F. (2020). Loss and Resilience in the Time of COVID-19: Meaning Making, Hope, and Transcendence. Family process, 59(3), 898–911.

[162]. Wang, H. (2021). Air Traffic Controllers' Occupational Stress and Performance in the Future Air Traffic Management. PhD Dissertations and Master's Theses. 570.

[163]. Wang, X., Miao, S., & Tang, J. (2019). Vulnerability and Resilience Analysis of the Air Traffic Control Sector Network in China. Sustainability, 12(9), 3749.

[164]. Wang, Y., et al. (2016). Human activity under high pressure: A case study on fluctuation scaling of air traffic controller's communication behaviors. Physica A: Statistical Mechanics and Its Applications, 441.

[165]. Wang, Z., & Sobey, A. (2020). A comparative review between Genetic Algorithm use in composite optimisation and the state-of-the-art in evolutionary computation. Composite Structures, 233, 111739.

[166]. Weick, K. E., & Sutcliffe, K. M. (2001). Managing the unexpected: Assuring high performance in an age of complexity. Work Study.

[167]. Wong, J. (2023). Develop And Manage Quality Customer Service Practices - Assessment TASK 2. Course Sidekick.

[168]. Xenikou A. (2017). Transformational leadership, transactional contingent reward, and organizational identification: the mediating effect of perceived innovation and goal culture orientations. Frontiers in Psychology.

[169]. Xiaotian E, & Jingyu Z. (2017). Holistic thinking and air traffic controllers' decision making in conflict resolution, Transportation Research Part F: Traffic Psychology and Behaviour. Volume 45.

[170]. Xiong, R., et al. (2023). Predicting separation errors of air traffic controllers through integrated sequence analysis of multimodal behavior indicators. Advanced Engineering Informatics.

[171]. Yakovytsk, L., et al. (2022). Psychological features of emotional stability as a safety factor of air traffic specialists. Transportation Research Procedia, 63.

[172]. Yang, Q., Dattel, A. R., & Beach, D. (2017). Task Complexity and Time Pressure Affect Air Traffic Controller's Performance and Workload. 19th International Symposium on Aviation Psychology.

[173]. Yang, T., & Jiang, X. (2023). When colleague got recognized: Third-party's reaction to witnessing employee recognition. Frontiers in Psychology, 14.

[174]. Yazgan, E., & Kucuk Yilmaz, A. (2018). Designing flow chart for aircraft type training in aviation training process management. Aircraft Engineering and Aerospace Technology, 90(9), 1346–1354.

[175]. Yiu, C., et al. (2021). A digital twin-based platform towards intelligent automation with virtual counterparts of flight and air traffic control operations. Applied Sciences.

[176]. Yonggang, W., & Wenting, M. (2023). Impact of Situational Awareness of Controllers on Safety Behavior Capacity in the Context of Air Traffic Control System with Manmachine Integration.

[177]. Yu, X., Chen, C., & Yang, H. (2023). Air traffic controllers' mental fatigue recognition: A multi-sensor information fusion-based deep learning approach. Advanced Engineering Informatics, 57, 102123.

[178]. Zamarreño Suárez, M., et al. (2022). How much workload is workload? A human neurophysiological and affective-cognitive performance measurement methodology for ATCOs. Aircraft Engineering and Aerospace Technology, Vol. 94 No. 9, pp. 1525-1536.

[179]. Zhang, X., et al. (2019). Effect of fatigue and stress on air traffic control performance. ICTIS 2019 - 5th International Conference on Transportation Information and Safety Institute of Electrical and Electronics Engineers Inc., (pp. 977–983).

[180]. Zhang, Y., et al. (2022). "In automation we trust" - Australian air traffic controller perspectives of increasing automation in air traffic management. Transport Policy, 125, 352–362.

[181]. Zhao, X. (2018). Study on the Reasons for the Mistakes in Air Traffic Control in Civil Aviation and Its Management Countermeasures. Proceedings of the 6th International Conference on Social Science, Education and Humanities Research.

[182]. Zhao L., et al. (2022). How does perceived respect affect innovative behavior? The role of thriving at work and spiritual leadership. Frontiers in Psychology.