RPPI
Revista Brasileira de Políticas Públicas e Internacionais

Assessment of the level of operational safety culture in the perception of professionals in air navigation service provider organizations in the Brazilian context

Avaliação do nível de cultura de segurança operacional na percepção dos profissionais de organizações provedoras de serviços de navegação aérea no contexto brasileiro

Thereza Christina Gama Prado Freire[1]
Ana Carolina Kruta de Araújo Bispo[2]
Flavio Perazzo Barbosa Mota[3]

DOI: [10.22478/ufpb.2525-5584.2023v8n2.66070]

Recebido em: 09/03/2023
Aprovado em: 09/10/2023

Abstract: This study evaluates the operational safety culture as perceived by professionals in air navigation service provider organizations within the Brazilian context. To achieve this, the theoretical review served as a basis for defining the dimensions of the operational safety culture that were investigated: Flexible Culture, Informed Culture, Learning and Reporting Culture, Managerial Attitudes towards Safety, and Just Culture. Measurement items for these dimensions were translated, adapted, and validated, including translator reviews, face and content validation, convergent validity, and reliability indicators. The analysis of results considered the perceptions of Air Traffic Professionals (ATPs) and Air Navigation Professionals (ANPs). It was identified that the mean scores attributed by ANPs were higher in all dimensions compared to ATPs. This result could be attributed to the nature of the roles of each group. From both theoretical and practical perspectives, applying this scale within the Brazilian context has advanced the study of this theme within national air traffic management. It is appropriate to consider that scores below 8.0, given the 11-point scale, should necessitate a higher level of attention in planning actions to improve safety performance.

Keywords: operational safety culture; air navigation, measurement scale.

[1] E-mail: thereza.prado@gmail.com.
[2] Universidade Federal da Paraíba. E-mail: ana.kruta@academico.ufpb.br.
[3] Universidade Federal da Paraíba. E-mail: flavioperazzo@ccsa.ufpb.br.

Resumo: Este estudo avalia a cultura de segurança operacional na percepção dos profissionais de organizações provedoras de serviços de navegação aérea no contexto brasileiro. Para tanto, a revisão teórica serviu de base para delimitar as dimensões da cultura de segurança operacional que foram investigadas: Cultura Flexível, Cultura Informada, Cultura de Aprendizado e Reporte, Atitudes dos Gestores com Relação à Segurança e Cultura Justa. Os itens de mensuração das dimensões foram traduzidos, adaptados e validados, incluindo: revisão por tradutores, validação de face e conteúdo, de validade convergente e indicadores de confiabilidade. A análise dos resultados considerou a percepção de Profissionais de Tráfego Aéreo (PTA) e Profissionais de Navegação Aérea (PNA). Identificou-se que as médias atribuídas pelos PNA foram, em todas as dimensões, maiores do que as dos PTA. Tal resultado pode decorrer da natureza da função de cada um dos grupos. Do ponto de vista teórico e prático, a aplicação da escala no contexto brasileiro possibilitou avançar nos estudos sobre a temática no gerenciamento de tráfego aéreo nacional. É apropriado considerar que médias inferiores à 8,0, dada a amplitude de 11 pontos, devem requerer maior nível de atenção no que se refere ao planejamento de ações para melhoria do desempenho da segurança.
Palavras–chave: cultura de segurança operacional; navegação aérea, escala de mensuração.

1. Introduction

The current concept of operational safety recognizes that hazards, failures, and operational errors are inherent in activities in complex environments. This applies, for example, to Air Traffic Control. It is unlikely to guarantee that accidents will never occur. This is especially true due to the interaction between humans and machines, despite advanced technologies. In this understanding, an organization is considered safe if it is able to continuously and systematically identify hazards and control the risks of its operational processes. Such continuous and systematic hazard identification, as well as risk control, are key components of the concept of operational safety management, which aims to adopt proactive measures before accidents occur (Brasil, 2015; Icao, 2018).

The approach to operational safety in this perspective solidified as air transportation became more popular over the years. This strengthening resulted from the improvement of approaches focused on accident studies and contributing factors investigations. In this context, academic literature emphasizes the importance of implementing operational safety management systems in Air Traffic Management. However, the effectiveness of this safety can be compromised by vulnerabilities resulting from a fragile operational safety culture (Eurocontrol, 2008).

This realization implies that the mere existence of an Operational Safety Management System does not ensure effective risk control, including harm to people,

property, or the environment – elements that define safe operations. This is because operational effectiveness depends on individual actions and contributions to safety culture. According to Gill and Shergill (2004), safety performance is influenced by how people perform their tasks, as they either adopt or do not adopt positive safety attitudes. This understanding has fueled the debate in the theoretical field of safety in high-risk industries and among regulatory authorities about the relationship between operational safety systems and safety culture (Gill & Shergill, 2004).

The operational safety culture, or simply safety culture, plays a recognized role in achieving high safety performance rates (Berg & Kopisch, 2012; Schwarz et al., 2016). When strengthened, this culture aligns norms with actual practices (values and attitudes), influencing safety outcomes (Eurocontrol, 2008). Therefore, it is essential to develop a tool to assess the operational safety culture as it allows for the identification of unobservable weaknesses in formal environments (Mearns et al., 2013).

In the context of air traffic management, this is especially critical compared to other high-risk industries. After all, air traffic controllers have direct and real-time contact with aircraft. They need to make quick decisions to resolve conflicts and deal with daily non-routine situations, in a matter of seconds. Consequently, flight safety depends directly on their work practices (Mearns et al., 2013). Therefore, the culture of operational safety must be measured, so that failures can be identified and corrected, maintaining acceptable levels of safety and the inherent reliability of Air Traffic Management (Brasil, 2017).

To that end, it is observed that some instruments have been developed for measuring the culture of operational safety in air traffic. Most of the tools developed have a quantitative focus (Mearns et al., 2013; Schwarz & Kallus, 2015), using questionnaires due to their ease of application. Qualitative approaches have also been used, through interviews or observations (Fruhen et al., 2013; Gordon et al., 2007). Additionally, there is academic literature documenting that the understanding of the culture of operational safety has advanced to study its relationship with other factors such as resilient behavior and psychological stress (Schwarz et al., 2016).

However, despite significant advances abroad, no records of the application of a scale in the context of Brazilian air traffic have been identified. Therefore, considering the issue presented, the guiding question of this study is as follows: What is the level of

operational safety culture in the perception of professionals from air navigation service provider organizations in the Brazilian context?

To answer this question, this work is organized as follows: first, a literature review is conducted on the evaluation of operational safety culture, outlining the concept and identifying the main metrics used in the literature. Next, methodological procedures for the selection, translation, and adaptation of a measurement scale are presented, applied to Air Traffic Professionals (ATP) and Air Navigation Professionals (ANP) within the context of an air traffic service provider organization in Brazil. Following this, the results and discussion are presented, including elements of validation, description, and comparison of perceptions between the two groups of respondents. Finally, concluding remarks are made, reflecting on the achievement of the objective, limitations, and suggestions for future research.

2. Evaluation of Operational Safety Culture in The Context of Air Navigation

The evaluation of the safety culture in organizations providing air navigation services has been the subject of various studies, particularly in the European continent, where most academic publications are concentrated. The research by Mearns et al. (2013) for the development of the Safety Culture Measurement Toolkit (SCMT) consisted of four phases, in which, in addition to the use of quantitative methods for questionnaire development, validation procedures were employed through interviews.

The first phase of Mearns et al. (2013) study involved a literature review from 2001 to 2005 to identify relevant themes contributing to the conceptual determination of the topic. In the second phase, interviews and focus group discussions were conducted within air navigation service organizations. The goal was to validate the themes identified in the first phase and construct the initial version of the questionnaire. In the third phase, the pilot questionnaire was administered, and item validity was tested through confirmatory and exploratory factor analysis. In the fourth and final phase, multiple interviews and focus groups were conducted to provide feedback. This phase not only allowed for the validation of issues arising from the questionnaire, but also facilitated the discussion of the subject with members of the organization (Mearns et al., 2013).

The model used by Mearns et al. (2013) considered three main themes: a) Reporting and Learning (incident reporting and change communication); b) Involvement in Safety Issues (team formation and management involvement); c) Safety Prioritization (support and commitment).The instrument developed by Mearns et al. (2013) was

distributed in 2007 to four air navigation service provider organizations in different European countries. From the analysis of the research, the authors identified weaknesses in the questionnaire that possibly contributed to incomplete construct validity in statistical tests. Some of the reported weaknesses may be related to language differences, item complexity, or different cultural aspects inherent to the national groups analyzed. Nevertheless, the instrument proved to be useful in identifying problems and solutions in the adoption of safety improvement measures.

Another study on the subject was conducted in Sweden, in two Air Traffic Control Centers and an administrative office of an air navigation service provider. Ek et al. (2007) developed a questionnaire comprising nine dimensions of operational safety culture as assessment instruments. The first four dimensions considered in the research instrument were the same as those defined by Reason (1997): a learning culture, a reporting culture, a fair culture, and a flexible culture. The other five dimensions added were derived from previous work for culture evaluation: communication, safety-related behaviors, safety attitudes, job situation, and risk perception.

The main results of the study conducted by Ek et al. (2007) indicated that the administrative unit obtained lower scores related to communication, reporting, and risk perception than the operational units, which can be explained by the nature of the work performed. Furthermore, the two operational units showed different perceptions regarding reporting and learning. In general, aspects related to culture scored above average, and the study also revealed that perception of culture varies depending on the individual's position. Another result was that demographic variables (e.g., gender) did not impact perceptions of culture, which was interpreted as a reflection of the training and education provided, which uniformly encompassed the personnel involved (Ek et al., 2007).

Another study conducted in New Zealand aimed to assess the safety culture in the civil aviation industry (Gill & Shergill, 2004). The sample consisted of 464 valid questionnaires filled out by professionals in the field. The majority of respondents were employees of airlines and air traffic controllers (Gill & Shergill, 2004). In the study, the questionnaire included two sets of dimensions: an organizational perspective on safety management and safety management systems and safety culture. The questions in the first set sought to assess the respondents' perceptions of the organization's role in promoting

safety. The second set also aimed to assess perceptions, with a focus on prevailing attitudes related to safety and how safety was managed in the organization.

The results indicated a possible lack of belief among respondents in safety management systems, as the personnel participating in safety activities and training themselves expressed the perception that "luck" and "safety" are the most important factors for aviation safety (Gill & Shergill, 2004). The collected data also revealed that managers did not assign adequate importance to recurrent training, safety activities, and the use of updated technologies for information management. This finding led the authors to emphasize the need for audits and the formulation of rules and policies to promote safety inherent to the activities of these professionals (Gill & Shergill, 2004).

On the other hand, Gonçalves Filho and Waterson's research (2018) was motivated by the observation that the use of safety culture maturity levels or stages has been growing. This research revealed that the most commonly used method to assess safety culture maturity levels is through questionnaires. Few studies have been conducted with the aim of applying the developed instruments, and an even smaller number has focused on verifying validity and reliability. Additionally, out of the selected works, only one was developed in the air traffic domain.

Gordon et al. (2007) conducted two safety research surveys at the Eurocontrol Experimental Centre (EEC), a Research and Development Center in the field of air traffic management in Europe. These authors compared two research methods to investigate their differences in terms of content and results presented, as well as to determine whether it was necessary to apply both methods to assess safety culture or if one of them alone would suffice.

The first questionnaire administered was the Safety Culture Survey (SCS), which contained items divided into dimensions such as management commitment, safety planning and organization, communication, trust and accountability, measurements, audits, and reviews (Gordon et al., 2007). The second instrument, named the River Diagram (RD), included items distributed across dimensions related to activities carried out at the EEC, such as policies, planning, scope, assurance, and promotion (Gordon et al., 2007). This instrument served as the basis for conducting semi-structured interviews, which helped identify the state of safety management system implementation at the EEC and potential measures for improvement (Gordon et al., 2007). Both instruments allowed for diagnosing safety culture in terms of maturity levels.

Despite recognizing a time gap between the applications of the two scales, which could have influenced the results obtained, Gordon et al. (2007) identified that each of the scales addressed different objectives, even though some of their content overlapped. The SCS proved to be more operational in identifying fundamental safety culture issues, with the anonymity it provided to respondents likely resulting in more realistic information. On the other hand, semi-structured interviews enabled clarification of possible questions related to survey items, indicating that the RD was more suitable for diagnosing the status of Safety Management System (SMS) implementation (Gordon et al., 2007).

Reader et al. (2015) investigated whether safety culture could be reliably assessed in an organization operating in different countries, with different national cultures, and if there was an association between safety cultures and national cultures. By researching 17 countries in four culturally distinct regions of Europe, the researchers collected data from questionnaires administered between 2011 and 2013 with over six thousand valid responses. The study revealed that safety culture models well adapted to a specific industry maintain satisfactory consistency beyond national borders and across occupational groups. Two questionnaires were used in the study, one for safety culture and another for national culture, and their metrics were compared. The safety culture questionnaire was structured around dimensions like management commitment to safety, collaboration for safety, incident reporting, communication, peer commitment to safety, and support for safety.

Based on the literature on the two subjects, Reader et al. (2015) formulated hypotheses to identify potential relationships between the safety culture construct and the sub-dimensions of the national culture variable. These sub-dimensions include collectivism, power distance, uncertainty avoidance, masculinity, and short-term orientation. In addition to finding that managers have more positive perceptions of safety compared to operators, the study indicated that five dimensions of safety culture, except for colleagues' commitment to safety, tend to be influenced by regional cultural norms. This led to the conclusion that safety culture is associated with features of national culture (Reader et al., 2015).

Another study related to safety culture assessment scales was conducted by Schwarz and Kallus (2015), who sought to validate the questionnaire developed by the Civil Air Navigation Services Organisation (CANSO). According to the authors, aside

from the questionnaire used to assess safety culture in this study, only one other has been used to evaluate safety culture, which is the Safety Culture Measurement Toolkit (SCMT) (Mearns et al., 2013). Both questionnaires originally encompassed eight dimensions. However, Schwarz and Kallus (2015) report that, after the validation procedures of the initial questionnaire, they obtained a resulting scale composed of five factors: informed culture, reporting and learning culture, fair culture, flexible culture, and safety attitudes of managers.

Schwarz and Kallus (2015) also dedicated themselves to investigating the relationships between safety culture and safety-relevant behavior (SRB). This latter construct includes aspects related to safety communication, compliance with safety rules, resilient behavior, leadership, safety participative behavior, and safety knowledge. They were investigated through semi-structured interviews to collect reports of safety behaviors from the last shift. The study's hypothesis that safety culture predicted safety-relevant behaviors (SRB) was confirmed by the authors for the dimensions of reporting and learning culture, fair culture, and safety attitudes of managers.

In Schwarz et al.'s (2016) research, the relationships between safety culture, resilient behavior, and stress in Air Traffic Management were studied, as the literature reviewed in this study pointed to indications that human capacity to handle changes, unforeseen situations, or the need for procedure adjustments can affect the organization's acceptable safety levels.

In the study by Schwarz et al. (2016), safety culture was assessed in the dimensions: "informed culture," "communication and learning," "fair culture," "flexible culture," and "Safety Management Attitudes." The research findings indicated that safety culture is negatively affected by psychological stress and positively affected by the ability to recover in adverse situations, which leads the authors to suggest that air navigation service providers and regulatory bodies consider the assessment of these variables to ensure the maintenance of high safety levels in their organizations.

Considering the literature review conducted, it was possible to identify scales that can measure operational safety culture in air navigation service provider organizations. The next topic, therefore, presents the choices made for the operationalization of the field research in the current study.

3. Method

To address the proposed research question, the theoretical review served as the foundation for decisions related to the methodological approach employed in this study. Furthermore, it helped to define the dimensions of the operational safety culture that were investigated. Therefore, the choice of a quantitative approach to assess safety culture is justified by the characteristics of the context in which the study is conducted and the absence of records of scale application in the Brazilian air traffic context.

In light of this, email contacts were established with authors of studies conducted in the international air traffic management context whose theoretical models were in line with Brazilian legislation, which aligns with the recommendations of the International Civil Aviation Organization (ICAO). In December 2019, requests were made to five authors for the provision of their respective safety culture scales (Ek et al., 2007; Mearns et al., 2013; Reader et al., 2015; Schwarz & Kallus, 2015).

Initially, only one author responded, providing the scale that had been used in three air traffic control units in Sweden (Ek et al., 2007). However, during the course of the research, in February 2020, Schwarz et al. (2016) provided their work, in which they reported research conducted in the European air traffic context. To develop the scale used in their study, Schwarz et al. (2016) relied on the work of Ek (2007), which was divided into five dimensions: (1) Informed Culture; (2) Reporting and Learning Culture; (3) Just Culture; (4) Flexible Culture; and (5) Manager Safety Attitudes. Responses to the questions were expressed on a four-point Likert scale: "strongly disagree," "disagree," "agree," "strongly agree."

The decision to translate the instrument used by Schwarz and Kallus (2015) and Schwarz et al. (2016) proved to be more advantageous when considering the continental dimensions of Brazil and the feasibility of applying the instrument. Furthermore, the effort already expended in terms of the validity and reliability procedures for this scale was taken into account, allowing for the adaptation of its metrics to the Brazilian context.

In this regard, with regard to the procedures for translating the scale, certain precautions were taken to avoid issues such as a lack of semantic equivalence between the source and target languages, a lack of conceptual equivalence between cultures, and a lack of normative equivalence between societies (Behling & Law, 2000). In consideration of these precautions, the methodological procedures described by Dias (2016) for adapting and translating scales for the Brazilian context were adopted. The

methodology presented by this author aims to overcome the limitations of the back-translation technique, one of the most well-known techniques used in the process of translating measurement instruments in the social and human sciences.

The first stage of the scale translation process involved the review of items by two translators with degrees in Literature and specialization in translation, considering the following dimensions: 1) "Flexible Culture"; 2) "Informed Culture"; 3) "Learning and Reporting Culture"; 4) "Fair Culture"; 5) "Managerial Attitudes Towards Safety". In the process, professionals were allowed to provide their own translation versions. After receiving the two proposed translations, a committee meeting was held to analyze and consolidate the received translations. The Committee consisted of three university professors with doctoral degrees from the institution the authors were affiliated with. It also included a student from the Doctoral program in Administration at the same university, who had experience in scale development and validation. Additionally, an external member with experience in operational safety and the researchers of this study were included.

The items resulting from the Committee's analysis were inserted into a Google Form for the next step of the process, related to face and content validation. In this form, two 5-point scales were assigned to each questionnaire item for the evaluation of clarity ("very poor," "poor," "fair," "good," and "very good") and content ("not suitable," "slightly suitable," "suitable," "quite suitable," and "completely suitable").

The face and content validation form was sent to Master's students and professors from a research group with which the authors were affiliated, as well as two other doctoral professors. After adjustments and decisions regarding item wording, a questionnaire pre-test was conducted. This stage took place through the Google Forms platform, in the workplace of one of the researchers of this article, who works in the air traffic control field. Thirteen responses were obtained, which indicated adjustments to items and the inclusion of sociodemographic variables.

Following the pre-test, the data collection phase began. An existing email distribution list in an air navigation service provider organization, which included individuals of interest to the research, was used. During the collection period, which occurred between July and August 2020, the organization was implementing COVID-19 pandemic response protocols, and all employees in administrative roles were working

remotely. In total, 258 respondents were obtained, of which 246 remained after removing duplicate cases and atypical observations.

Furthermore, it was decided to only consider respondents who held the positions of Air Traffic Professionals (ATP) and Air Navigation Professionals (ANP), as they represented the largest number of respondents in the sample, ensuring a balance in the number of cases obtained. This decision allowed for comparisons between the groups and was in line with the studies (Ek et al., 2007; Schwarz & Kallus, 2015) that informed the choice of the scale used. It should be noted that the metric used has a generalist character, with the anticipation of application to the entire air navigation sector. After this selection criterion, the final sample resulted in 191 valid cases. The following section presents the results, starting with the descriptive profile, followed by evidence of scale validity and group comparisons.

4. Results and Discussion

In descriptive terms (Table 1), the majority of research participants were male (70%), had completed higher education (54%), and did not hold a position of trust (79%). There was a reasonable balance in terms of time in the position, age range, and professional areas of operation. With regard to the position, 51% of the sample consisted of Air Traffic Professionals, and 49% were Air Navigation Professionals.

Table 01: Sample Description

Profile	n	%
Gender		
Female	58	30
Male	133	70
Education		
High School Completed	37	19
College Degree Completed	104	54
Postgraduate (Completed Specialization, Master's, or Ongoing Doctorate)	50	26
Trust Position		
Yes	41	21
No	150	79
Time in Position		
Less than 10 years	52	27
Between 10 and 20 years	55	29
Between 20 and 30 years	61	32
More than 30 years	23	12
Age Group		
Up to 30 years	10	5
Between 30 and 40 years	40	21
Between 41 and 50 years	61	32
More than 51 years	80	42
Region		
NASE-4 (Belém)	8	9

NASE-6 (Recife)	32	17
NASE-8 (Belo Horizonte)	33	17
NASE-10 (São Paulo)	63	33
NASE-12 (Porto Alegre)	30	16
Others	15	8

In order to obtain validity evidence for the scale (Table 2), it is expected that the extracted variance exceeds 50% in each dimension of the operational safety culture construct, and the factor scores are above 0.5 in the factor analysis (Costa, 2011; Hair et al., 2005). Additionally, internal consistency (reliability) was assessed through Cronbach's alpha, with values expected to be above 0.6 (Costa, 2011). Considering that the checks performed in this stage involve procedures for variable reduction by verifying the fit of the item set to the factors (Costa, 2011), the Fair Culture dimension (FC) was not included in the analysis, as it consists of only two items.

It was found that all dimensions met the validity criteria in this stage. In all dimensions, only one iteration of principal component analysis and varimax rotation was required to achieve a proper fit. Good reliability was also demonstrated, indicating an improvement compared to the studies that served as the basis for the scale applied in this research.

Table 02: Summary of the psychometric consistency of the Safety Culture Scale

Dimension	Number of Items	Variance extraction (%)	Lower score	Cronbach's *Alpha*
Flexible Culture	8	74,36	0,73	0,95
Informed Culture	7	71,90	0,82	0,93
Learning and Reporting Culture	5	76,73	0,85	0,92
Managerial Attitudes Toward Safety	6	81,87	0,83	0,95

Table 3 summarizes the descriptive measures and correlations between the constructs. It presents the aggregated means of the items and the standard deviation (SD). The fair culture scored the highest, while the flexible culture received the lowest evaluation. The results are consistent with the analyzed context. The fair culture is related to not punishing errors inherent to human nature and treating violations rigorously. The flexible culture is related to the ability to adapt to unforeseen situations. The analyzed context, due to its essentially standardized nature and the fact that employees undergo various training, may contribute to these levels of perception. These levels can be

exacerbated by a misinterpretation of the requirements, considering that in the organization, there is no flexibility, and errors are not allowed.

Table 03: Descriptive measures and discriminant validity summary of the Safety Culture

Dimension	Mean	SD	1	2	3	4
1 Flexible Culture	6,77	2,40	-			
2 Informed Culture	7,47	2,05	0,88	-		
3 Learning and Reporting Culture	7,66	2,18	0,75	0,78	-	
4 Managerial Attitudes Regarding Safety	8,28	2,12	0,64	0,73	0,79	-
5 Fair Culture	8,84	1,35	0,53	0,61	0,54	0,52

The next stage of analysis corresponds to comparisons between the groups (Table 4) of Air Traffic Professionals (ATP) and Air Navigation Professionals (ANP), using the student's t-test. When analyzing the responses of air traffic professionals (ATP), it was found that flexible culture obtained the lowest mean among the safety culture dimensions, and fair culture the highest mean.

Table 04: Comparison between ANP and ATP by dimension

Dimension	Group	Mean	SD	t	gl	p-value
FC	ANP	7,47	2,00	4,10	189	0,001
	ATP	6,10	2,56			
IC	ANP	8,10	1,51	4,30	189	0,001
	ATP	6,87	2,31			
LRC	ANP	8,14	1,70	3,04	189	0,003
	ATP	7,20	2,48			
FC	ANP	9,13	0,98	2,93	189	0,004
	ATP	8,57	1,59			
MARS	ANP	8,59	1,76	2,01	189	0,046
	ATP	7,98	2,38			

The item of flexible culture that obtained the lowest results was: "Top management explicitly values employees' knowledge and experiences." It is worth noting that this item on Ek et al.'s scale (2007) also received negative results from approximately 20% of respondents in two control centers studied. It is understood that the valuation of knowledge and experiences contributes to better adaptation of individuals to changes, producing resilient behavior (Heese, 2012). This aspect is particularly relevant in the context of air traffic control, where unexpected situations may require immediate decisions.

Although the negative perception regarding this item is similar to the Swedish study (Ek et al., 2007), it is possible that, in the context of this research, this result is related to the scenario faced by the aviation sector during data collection. This was due

to a significant decrease in air traffic movement due to the COVID-19 pandemic, resulting in a reduction in operational staff in ATC organizations due to disease prevention and containment measures.

Additionally, the organization where data collection took place is undergoing a major change process, involving the privatization of airports. In this process, many employees were reassigned to other public agencies and encouraged to participate in voluntary resignation plans. Therefore, it is understood that this context disadvantages the perception of employee appreciation and recognition.

Regarding the dimension "Management Attitudes toward Safety," the average obtained from air traffic controllers was positive, as managers have an influence on developing a positive safety culture (Fruhen et al., 2013; Tear et al., 2020). The "just culture" dimension, despite consisting of only two items, had the highest average of all the dimensions analyzed in the perception of air traffic controllers. This result aligns with the results of Ek et al.'s study (2007), where the corresponding items in this dimension received 20% or more negative responses. This positive evaluation of just culture in the Brazilian context may be related to the extensive dissemination of policies addressing the topic and incident handling processes.

In addition, it was identified that the averages assigned by Air Navigation Professionals (PNA) were higher than those of Air Traffic Professionals (PTA) in all dimensions. PNA professionals do not perform front-line air traffic control activities. However, these professionals interact daily with the air traffic control service and are involved in various operational safety processes, which may explain their high perception of safety culture. Another factor that may explain the high scores, especially among PNA professionals, is related to the portion of these professionals who previously worked in the Aeronautical Information Service. They were recently reassigned to work in the company's operational safety areas due to changes in the mode of service provision in several Brazilian AIS rooms, which resulted in the elimination of operational work positions for these professionals.

The adaptation to the new scenario and dedication to learning the new activity may have contributed to the result. However, further investigation is recommended, including determining to what extent the safety climate influenced this result. A recent study conducted in Europe involving 13,616 air traffic controllers from 21 countries

corroborated that there are differences in safety culture perceptions among professionals with different hierarchical positions (Tear et al., 2020).

In addition, the averages obtained by respondents, according to their statements of having or not having a position of trust in the context of the organization where data was collected, were examined, implying a higher hierarchical position compared to the total workforce. It was observed that, for all dimensions of this study, the group holding positions of trust, namely, the management, had more positive perceptions compared to the group without positions of trust.

In the Brazilian context, this result may be related to the direct involvement of management in handling operational safety matters and processes, such as incident and accident analysis, statistical data analysis, and participation in operational safety committee meetings. In this sense, the actions to promote operational safety developed within the company, involving all hierarchical levels, may be a promising path to align perceptions between the two groups.

5. Considerations

The concept of a safety culture in aviation is considered a key factor in preventing accidents and incidents. In other words, it drives the use of processes and tools capable of promoting operational oversight and learning before aviation disasters occur. In this context, safety culture focuses on the operational perspective. This means that it's important to assess how this culture affects the safe performance of aviation operations. In such operations, people have the responsibility of ensuring the smooth and safe operation of the aircraft under their control.

The application of the scale in the Brazilian context has allowed for advancements in the study of this topic in national air traffic management. The instrument, which showed evidence of validity in the Brazilian context, aimed to fill the gap in research predominantly conducted in Europe on the subject, as identified by Reader et al. (2015). However, it should be noted that the "fair culture" dimension, composed of only two items, was not included in the validity and reliability checks.

In the studies by Ek et al. (2007), the reliability test, through the analysis of Cronbach's alpha on the data, returned a value of 0.65 for this dimension. This dimension also posed problems in the studies of Schwarz and Kallus (2015), showing an alpha of 0.54 for the sample of air traffic controllers involved in the research. Considering that European air traffic control regulations require a just culture as one of the safety

performance indicators, these authors proposed that future studies proceed with new rounds of validation, including new items. Therefore, in the use of the scale for future assessments, it is recommended to pay attention to and carefully analyze this dimension in the Brazilian scenario.

From a practical perspective, since the instrument used an 11-point Likert scale to assess perceptions of safety culture, where respondents assign lower scores to "Strongly Disagree" and higher scores to "Strongly Agree," it is appropriate to consider items with averages above 8.0 as high levels. In other words, averages below this value should require more attention from the organization in terms of planning actions to improve safety performance.

Despite achieving the intended goal in this study, there were limitations. The data collection period's context, affected by the COVID-19 pandemic, had a significant impact on the aviation sector, leading to a 90% reduction in the national air network and direct effects on the population under study. This may have contributed to the perceptions being influenced by contextual factors, typical in questionnaire-based surveys. For example, the distancing from the work environment may have led to a detachment from the actual perception being measured. Therefore, the replication of this scale is necessary in future studies.

Furthermore, the research models used by Ek et al. (2007) and Schwarz et al. (2016) assume that safety culture should be measured using multiple methods, including questionnaires, interviews guided by psychologists, and observation of real operations, to obtain confirmation and a better understanding of the data obtained with objective tools. This suggests that future studies in the Brazilian context should use the scale developed in this research to guide investigations through the complementary methods mentioned (Ek et al., 2007; Schwarz et al., 2016). This is expected to lead to improvements in operational safety performance in each unit being evaluated for safety culture.

Finally, it's worth noting that the study was limited to comparing the profiles of PTA and PNA positions. A more in-depth investigation could include potential differences in other sociodemographic variables (e.g., gender, age, years of experience in the role, location of work, occupation of a position of trust, and regions of the country). It's understood that this type of analysis can provide valuable information about how respondents' perceptions are influenced by these factors. Tear et al. (2020) report that safety culture perceptions are influenced by an individual's position within the hierarchy

and national values regarding power distance. Therefore, considering that the study by these researchers involved multiple countries and that Brazil is a country with continental proportions, with each region having its specific cultural values, it's reasonable to suggest that similar investigations conducted at the national level can be explored in future studies. This is particularly relevant for guiding the organization's actions in a relevant and appropriate manner to the needs of each region.

Referencias

Behling, O., & Law, K. S. (2000). Translating questionnaires and other research instruments: problems and solutions. Sage Publications.

Berg, H. P., & Kopisch, C. (2012). Safety Culture and its Influence on Safety. Journal of KONBiN, 23(1), 17–28.

Brasil. Ministério da Defesa. Comando da Aeronáutica. (2015). Sistema de Gerenciamento da Segurança Operacional no SISCEAB: DCA 63-3.

Brasil. Ministério da Defesa. Comando da Aeronáutica. Departamento de Controle do Espaço Aéreo. (2017). Cultura de Segurança Operacional no SISCEAB: MCA 63-19.

Costa, F. J. (2011). Mensuração e Desenvolvimento de Escalas. Editora Ciência Moderna.

Dias, J. J. L. (2016). Adaptação e Tradução de Escalas de Mensuração para o Contexto Brasileiro: um Método Sistemático como Alternativa a Técnica Back-Translation. Métodos e Pesquisa em Administração, 1(2).

Ek, Å., Akselsson, R., Arvidsson, M., & Johansson, C. R. (2007). Safety culture in Swedish air traffic control. Safety Science, 45(7), 791-811.

Eurocontrol. (2008). Safety culture in air traffic management: A white paper. https://www.skybrary.aero/bookshelf/books/564.pdf

Fruhen, L. S., Mearns, K. J., Flin, R. H., & Kirwan, B. (2013). From the surface to the underlying meaning-an analysis of senior managers' safety culture perceptions. Safety science, 57, 326-334.

Gill, G. K., & Shergill, G. S. (2004). Perceptions of safety management and safety culture in the aviation industry in New Zealand. Journal of Air Transport Management, 10(4), 231-237.

Goncalves Filho, A. P., & Waterson, P. (2018). Maturity models and safety culture: A critical review. Safety science, 105, 192-211.

Gordon, R., Kirwan, B., & Perrin, E. (2007). Measuring safety culture in a research and development centre: A comparison of two methods in the Air Traffic Management domain. Safety Science, 45(6), 669-695.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2005). Multivariate Data Analysis (6th ed.). Prentice-Hall International.

Heese, M. (2012). Got the Results, Now What Do You Do?: Safety Culture Transformation From Theory Into Practice. Aviation Psychology and Applied Human Factors, 2(1), 25–33.

Icao. INTERNATIONAL CIVIL AVIATION ORGANIZATION. (2018). DOC 9859: Safety Management Manual. International Civil Aviation Organization.

Mearns, K., Kirwan, B., Reader, T. W., Jackson, J., Kennedy, R., & Gordon, R. (2013). Development of a methodology for understanding and enhancing safety culture in Air Traffic Management. Safety science, 53, 123-133.

Reader, T. W., Noort, M. C., Shorrock, S., & Kirwan, B. (2015). Safety sans Frontieres: an international safety culture model. Risk analysis, 35(5), 770-789.

Reason, J. T. (1997) Managing the risks of organizational accidents. Ashgate.

Schwarz, M., & Kallus, K. W. (2015). Safety culture and safety-relevant behavior in air traffic management. Aviation Psychology and Applied Human Factors, 5(1), 3-17.

Schwarz, M., Kallus, K. W., & Gaisbachgrabner, K. (2016). Safety culture, resilient behavior, and stress in air traffic management. Aviation Psychology and Applied Human Factors, 6(1), 12.

Tear, M. J., Reader, T. W., Shorrock, S., & Kirwan, B. (2020). Safety culture and power: Interactions between perceptions of safety culture, organisational hierarchy, and national culture. Safety science, 121, 550-561.