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Exploring Collegiate Flight Training Students' Perceptions of Safety Culture

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As flight training organizations expand and adapt to meet the growing demands of the industry, organizational leadership and safety departments are continuing to intensively focus on aviation safety and quality assurance through the core values of safety promotion, culture, and education. A flight school's safety culture, shaped by students' risk perceptions, can predict safety behaviors. Understanding students' trust and confidence in this safety culture could potentially aid in early risk mitigation strategies. The purpose of this study was to investigate flight students' perceived safety culture at a Title 14 Code of Federal Regulations (CFR) Part 141 flight training school in the Southeast region of the United States. The survey was adapted from the Safety Culture Indicator Scale Measurement System. Quantitative and qualitative data were obtained from 398 students. Confirmatory factor analysis and structural equation modeling were used to test structural relationships among organizational commitment, operations interactions, formal safety indicators, and safety behaviors. Results indicated a good model fit for analyzing the nine hypotheses. Two of the nine hypotheses were supported. Safety Values and Safety Personnel significantly influenced perceived personal risk. The textual data analysis revealed strong student opinions towards a medical grounding and no-show procedure initiated by the Flight Department. Additionally, themes identified students' desire to receive more communication of safety information, and the language barriers present in a multi-cultural operation.

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Introduction

An Alaska Department of Public Safety (DPS) helicopter encountered a snowstorm and poor visibility while attempting to rescue a stranded snowmobiler in Alaska, ultimately resulting in a crash (National Transportation Safety Board [NTSB], 2014). The NTSB identified an unhealthy safety culture within the DPS as one of the contributing factors to the mishap. According to the Agency, the Alaska DPS had a "punitive safety culture that impeded the free flow of safety-related information and impaired the organization's ability to address underlying safety deficiencies relevant to this accident" (p. viii). The term safety culture first appeared during the investigation of the Chernobyl disaster in 1986. Organizational pressures, program shortcomings, and a flawed safety culture were also causal factors of the Space Shuttle Columbia disaster in 2003 (National Aeronautics and Space Administration [NASA], 2003). Safety culture is a multi-dimensional construct and includes an informed culture, a reporting vulture, a just culture, a flexible culture, and a learning culture (Reason, 1998).

> Safety culture refers to the enduring value, priority, and commitment placed on safety by every individual and every group at every level of the organization. Safety culture reflects the individual, group, and organizational attitudes, norms, and behaviors related to the safe provision of air navigation services (Civil Air Navigation Services Organization, 2008, p. 1).

Until the early 1970s, accident investigators and researchers focused on weather conditions, technological failures, and especially human errors as root causes of accidents. However, aviation professionals began to recognize that errors and violations are often triggered by organizational factors such as organizational climate, safety culture, safety oversight, safety values and beliefs, and safety programs. Aircraft accidents and incidents are typically the result of multiple contributing factors, with frontline personnel's unsafe acts (e.g., pilots) often influenced by organizational factors and latent conditions (Shappel et al., 2007).

Effective safety management requires much more than just a safety office and safety standards and procedures. According to Ayres Jr. et al. (2009), Safety Management Systems (or any safety program) are most effective in organizations with a strong safety culture. A strong safety culture is difficult to quantify. Nonetheless, in an organization with a healthy safety culture, personnel are proactive and understand that they are responsible and accountable for the safety of their organization. Moreover, employees truly understand the risks associated with their jobs and take action to mitigate those risks. Additionally, they strongly believe that safety should not have to come at the cost of productivity. Most importantly, safety is an integral part of the education and training personnel receive so that they have the knowledge and skills to work safely and effectively (Ayres Jr. et al., 2009).

There is an inherent risk associated with flight training in a collegiate aviation environment (Byrnes et al., 2022). Organizational factors such as the organization's safety climate and safety culture play significant roles in the safety efforts in such a system. Previous studies have suggested that organizations with a healthy safety culture are less prone to experiencing safety related events. Thus, it is important to better understand the safety culture of students in a Part 141 college flight program. Findings can provide Part 141 flight training schools with data and information to develop or enhance their safety management systems.

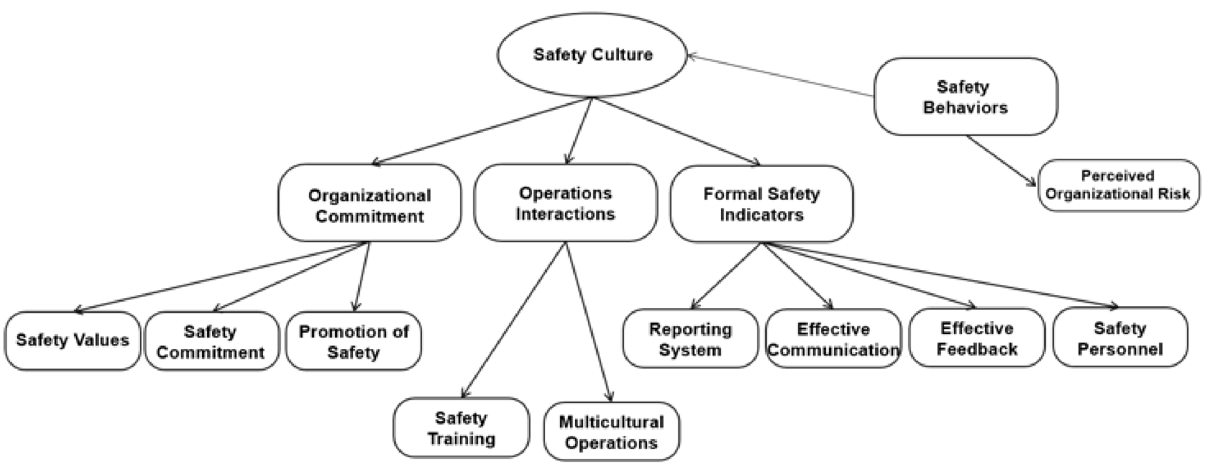
Methodology

Survey Framework

The purpose of the study was to investigate flight students' safety culture at a Title 14 Code of Federal Regulations (CFR) Part 141 flight training school in the Southeast region of the United States. A survey was conducted to determine the relevant factors influencing flight students' perception of the organization's safety culture. The quantitative results of the survey were then analyzed using Structural Equation Model (SEM) techniques. SEM in the form of a relational path model was used to test hypotheses postulated about predictive relationships between the factors and the dimension of safety culture. It was also used to determine the strength of relationships between these factors and the dimension of safety culture. Additionally, researchers generated a Word Cloud from the limited qualitative data, as explained in the results section of this manuscript.

The questions selected for use in the survey were drawn from the Safety Culture Indicator Scale Measurement System (SCISMS), originally based on the Commercial Aviation Safety Survey (CASS). Factors affecting students' perceived safety culture were divided into second-order factors, including organizational commitment, operations interactions, and formal safety indicators. Second-order observed variables were then developed.

Figure 1
Modified safety culture framework.



The survey included two open-ended questions, allowing respondents to provide suggestions and comments (see below). The open-ended questions were optional and not mandatory to successfully complete the survey.

1. Please describe any additional comments you have regarding safety in the Flight Department.
2. Please describe any recommendations for improving safety in the Flight Department.

Survey Distribution

After Institutional Review Board (IRB) approval was obtained, purposeful sampling was used to target the population of interest. The survey was administered through Microsoft Forms in the English language to allow for simplicity of delivery and anonymity of participants. Participants were assured of the confidentiality of their responses. The survey was open for two weeks.

Hypotheses

The following hypotheses were investigated in the study:

H_1: Safety values significantly influence perceived organizational risk
H_2: Promotion of safety significantly influences perceived organizational risk
H_3: Safety commitment significantly influences perceived organizational risk
H_4: Reporting system significantly influences perceived organizational risk
H_5: Effective communication significantly influences perceived organizational risk
H_6: Effective feedback significantly influences perceived organizational risk
H_7: Safety personnel significantly influences perceived organizational risk
H_8: Safety training significantly influences perceived organizational risk
H_9: Multicultural operations significantly influence perceived organizational risk

Population

The population of interest consisted of 1,501 active flight students at a large, accredited Title 14 CFR Part 141 flight training and four-year degree-awarding university in the Southeast regions of the United States (FAA, 2017). The sample (n = 398) was drawn from active flight students accounting for approximately 27% of the population.

Results

Demographics

Demographic information such as gender, age, enrollment status, and international status were collected during the survey. Table 1 shows the demographics of the sample (n=398). Almost 24% of the respondents were international students. Fifty–eight of these students were juniors or seniors. Interestingly, most respondents (80.9%) had not filed a safety report before.

Among all the respondents, 82.2% were men, 17.1% were women, and 0.8% preferred not to say. The gender ratio disbursement of the sample was representative of the population demographics, which has a male-female ratio of 83.3% to 16.7%. Most respondents were domestic students (76.6%). This was also representative of the population with a 77.7% domestic student population.

Table 1
Demographic Variables

Characteristics	Subgroup Categories	Frequency	Percentage
International	International	93	23.4%
	Domestic	305	76.6%
		398	100%
Private Pilot License	Internally earned	169	42.5%
	Earned elsewhere	144	36.2%
	No License received	85	21.4%
		398	100%
Flight Certifications	Student Pilot	91	22.9%
	Private	94	23.6%
	Instrument	104	26.1%
	Commercial-Single	56	14.1%
	Commercial-Multi	16	4.0%
	CFI	16	4.0%
	CFI-I	20	5.0%
	Multi Instructor	1	0.3%
		398	100%
Enrollment	Freshman	93	23.4%
	Sophomore	68	17.1%
	Junior	113	28.4%
	Senior	117	29.4%
	Graduate	7	1.8%
		398	100%
Age	Below 20	128	32.2%
	20-25	249	62.6%
	26-30	16	4.0%
	31-35	2	0.5%
	36-40	2	0.5%
	41-45	0	0%
	46-50	1	0.3%
	Above 50	0	0%
		398	100%
Gender	Male	327	82.2%
	Female	68	17.1%
	Prefer not to say	3	0.8%
		398	100%

Table 1 (*continued)*

Characteristics	Reports Submitted	Frequency	Percentage
Safety Report	0	322	80.9%
	1	52	13.1%
	2	13	3.3%
	3	6	1.5%
	4	4	1.0%
	5	1	0.3%
		398	100%

Analysis of the Responses to the Safety Culture Questionnaire

The current study examined the impact of nine factors – safety values (SV), promotion of safety (PS), safety commitment (SC), reporting system (RS), effective communication (EC), effective feedback (EF), safety personnel (SP), safety training (ST), and multicultural operations (MP) – on perceived organizational risk (SR). In the survey questionnaire, each factor was measured by three- to five-item questions. The respondents were asked to evaluate these items based on a 5-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree). Table 2 shows the values of the mean and standard deviation of the scale items. Figure 2 shows the final specified CFA model, and Figure 3 shows the final specified SEM model.

The sample mean (M) is the average of the observations, and SD indicates the dispersion of individual observations about M. Both the sample mean and standard deviation play important roles, particularly in the context of model fit evaluation and parameter estimation. When the observations are more dispersed, then there will be more variability. In this case, a relatively low SD signifies less variability of data.

Table 2
Mean and Standard Deviation Scores of Constructs

Construct		*M*	*SD*
Safety Values	SV1	4.37	0.816
	SV2	3.54	1.066
	SV3	4.26	0.779
	SV4	4.19	0.865
	SV5	3.90	1.138
Promotion of Safety	PS1	4.09	0.785
	PS2	4.08	0.805
	PS3	4.42	0.723
	PS4	4.40	0.780
	PS5	4.48	0.683
Safety Commitment	SC1	4.21	0.745
	SC2	4.27	0.746
	SC3	3.46	1.176
	SC4	4.15	0.806
Reporting System	RS1	3.71	0.845
	RS2	3.82	0.959
	RS3	4.07	0.766
	RS4	4.07	0.819
Effective Communication	EC1	3.80	0.957
	EC2	3.90	0.884
	EC3	3.97	0.841
	EC4	3.88	0.927
Effective Feedback	EF1	3.79	0.794
	EF2	3.84	0.805
	EF3	3.82	0.817
	EF4	3.39	1.114
Safety Personnel	SP1	4.04	0.810
	SP2	4.07	0.731
	SP3	4.16	0.755
	SP4	4.16	0.724
Safety Training	ST1	4.20	0.801
	ST2	4.10	0.924
	ST3	4.25	0.757
	ST4	4.36	0.698
Multicultural Operations	MO1	3.49	1.153
	MO2	4.00	0.946
	MO3	3.73	1.152
Safety Behaviors	SR1	3.27	1.163
	SR2	2.90	1.197
	SR3	3.51	1.133

Figure 2
The final specified CFA model.

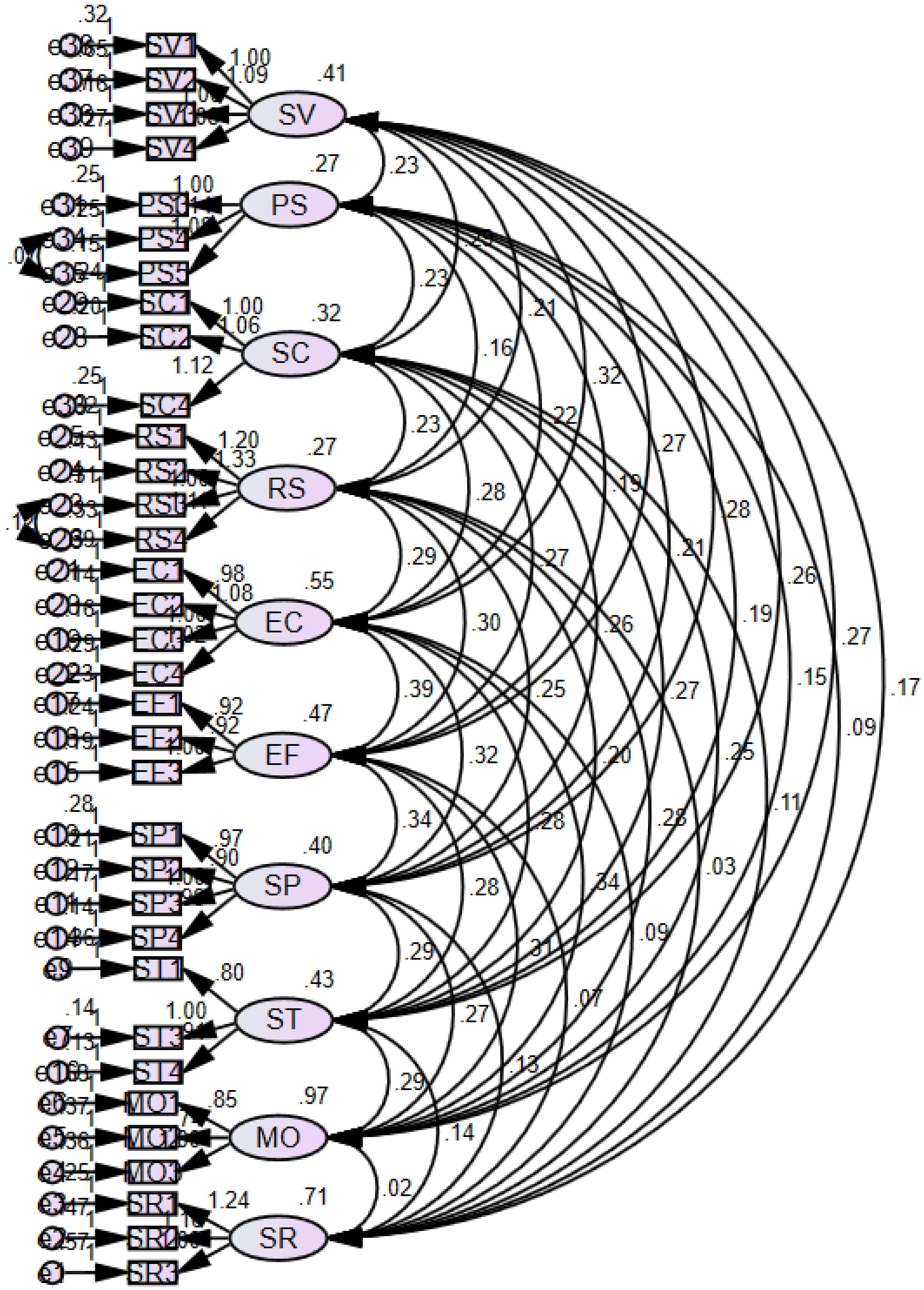
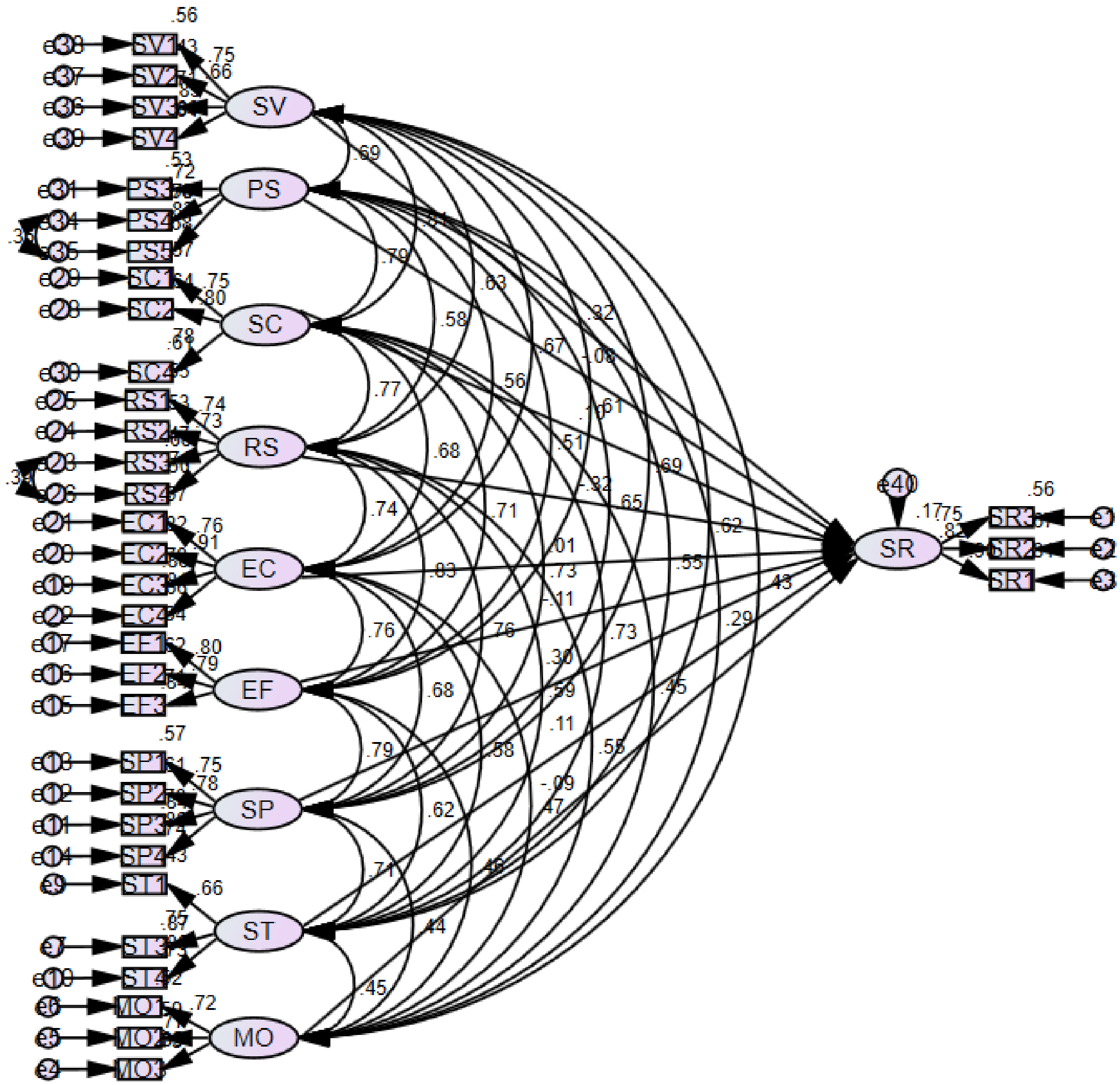


Figure 3
The final specified SEM model.



Convergent validity and discriminant validity were examined for the final specified CFA model. PS1, PS2, SC3, EF4, and ST2 items were removed from the initial specified CFA model for reliability and validity. Four indicators of convergent validity were evaluated, including factor loadings, Construct Reliability (CR), Average Variance Extracted (AVE), and Maximum Shared Variance (MSV). The acceptance value for factor loading was ≥ .65, CR was ≥ .70, Cronbach's alpha was ≥ .70, and AVE was ≥ .50 (Hair et al., 2010; Vogt et al., 2012). All the standardized factor loadings passed the .65 threshold, and the CR and Cronbach's alpha were greater than .70, indicating satisfactory consistency among items. AVE values for all factors were greater than .05, indicating satisfactory convergent validity. Table 3 shows the results of the convergent validity assessment for the final CFA model.

Table 3
Convergent validity assessment of the final CFA model.

Construct	Item	Factor Loading	Squared multiple correlations	CR	Cronbach's alpha	AVE
SV	SV1	.75	.56	.78	.83	.59
	SV2	.66	.44			
	SV3	.85	.72			
	SV4	.80	.64			
PS	PS3	.73	.53	.82	.84	.60
	PS4	.76	.58			
	PS5	.83	.69			
SC	SC1	.75	.56	.82	.82	.60
	SC2	.80	.64			
	SC4	.78	.61			
RS	RS1	.74	.55	.81	.82	.51
	RS2	.73	.53			
	RS3	.68	.46			
	RS4	.71	.50			
EC	EC1	.76	.58	.91	.90	.71
	EC2	.91	.83			
	EC3	.88	.77			
	EC4	.81	.66			
EF	EF1	.80	.64	.85	.85	.66
	EF2	.79	.62			
	EF3	.84	.71			
SP	SP1	.75	.56	.88	.88	.65
	SP2	.78	.61			
	SP3	.84	.71			
	SP4	.86	.74			
ST	ST1	.66	.44	.84	.83	.64
	ST3	.87	.76			
	ST4	.86	.74			
MO	MO1	.72	.52	.82	.82	.61
	MO2	.77	.59			
	MO3	.85	.72			
SR	SR1	.90	.81	.87	.86	.68
	SR2	.82	.67			
	SR3	.75	.56			

Note. CR = Construct Reliability, AVE = Average Variance Extracted

Discriminant validity was tested by using the Fornell-Larcker method, which compared the AVE values to the correlation estimates between the constructs, as shown in Table 4. If the square root of AVE is greater than the correlation estimates, the discriminant validity is supported (Zait & Bertea, 2011). Table 4 shows the discriminant validity values. Discriminant validity showed large values for four correlations. However, the correlation between SC and SV, as well as SC and PS, can be explained by the framework in Figure 1. All three variables are the second factors of organizational commitment. Additionally, the correlation between RS and EF, as well as RS and SP, can also be explained by the framework. RS, EF, and SP are the second-factor variables of formal safety indicators.

Table 4
Discriminant Validity Values

	SV	PS	SC	RS	EC	EF	SP	ST	MO	SR
SV	**.768**									
PS	.688	**.775**								
SC	**.808**	**.788**	**.775**							
RS	.634	.583	.769	**.714**						
EC	.674	.564	.684	.739	**.843**					
EF	.607	.515	.712	**.828**	.765	**.812**				
SP	.687	.650	.732	**.761**	.680	.786	**.806**			
ST	.617	.549	.733	.585	.581	.615	.713	**.800**		
MO	.435	.290	.447	.547	.473	.465	.440	.454	**.781**	
SR	.313	.207	.233	.068	.150	.115	.253	.257	.027	**.825**

Structural Model Assessment

The final CFA model in Figure 1 was transformed into a SEM model, as shown in Figure 2. The endogenous variable was perceived personal risk. The data was then assessed for normality and outliers. All kurtosis values were less than 5.00, and squared Mahalanobis values were less than 65. Two error covariances were created between error terms from the largest MI values.

Overall Model Fit

The same acceptance value was used to analyze the model fit. Two pairs of covariances were added between the largest values of error terms. The revised SEM model indicated an acceptable model fit, as shown in Table 5. The Goodness of Fit (GFI) is the proportion of variance accounted for by the estimated population covariance (Hair et al., 2010). The GFI value was slightly off the acceptance value but tolerable (Hu & Bentler, 1999). Hu and Bentler (1999) supported the idea that although a GFI value larger than .90 is recommended, a value larger than .80 may be used with caution.

Table 5
Model Fit Indices for the Final CFA Model

Model Fit Index	Acceptance Value	Final Model
X^2	-	853.324
df	-	481
Probability	>.05	***
GFI	>.90	.888
NFI	>.90	.906
CFI	>.95	.956
CMIN/df	≤ 3.00	1.774
RMSEA	<.06	.044

Note. *** significant at $p < .001$. GFI = Goodness of Fit Index, NFI = Normed-Fit Index, CFI = Comparative Fit Index, RMSEA = Root Mean Square Error of Approximation.

Following the model estimation, hypotheses were tested. Figure 4 illustrates the standardized regression weights for the SEM model. Table 6 shows the standardized path coefficients and *t*-values for the SEM model. Hypotheses with *p*-values less than .05 were supported. H_1 and H_7 had path estimates that were statistically significant in the expected direction, indicating that safety value and safety personnel were significantly correlated with perceived personal risk.

Figure 4
Standardized regression weights for the SEM model.

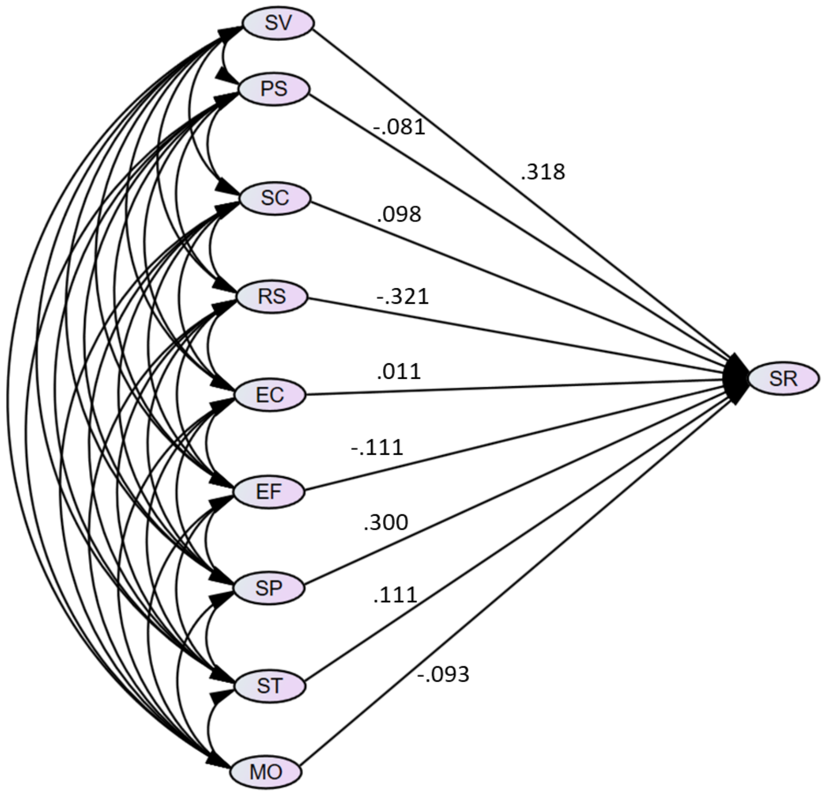


Table 6
Hypothesis Testing Results

Hypotheses	Relationships	SRW	*t*-values	*p*-values	Result
H_1	SV → SR	0.318	2.402	.016	Supported
H_2	PS → SR	-0.081	-0.595	.552	NS
H_3	SC → SR	0.098	0.409	.683	NS
H_4	RS → SR	-0.321	-1.706	.088	NS (Close)
H_5	EC → SR	0.011	0.102	.919	NS
H_6	EF →SR	-0.111	-0.682	.495	NS
H_7	SP → SR	0.300	2.011	.044	Supported
H_8	ST → SR	0.111	0.945	.345	NS
H_9	MO → SR	-0.093	-1.216	.224	NS

Note. SRW = Standardized Regression Weights, NS = Not Supported, SR was reverse-coded, so the direction of the SRW and *t*-values should be opposite.

Analysis of the Qualitative Data

As previously noted, the survey included two open-ended questions, allowing respondents to provide invaluable qualitative information. While not all respondents provided an open-ended response, 162 comments were received for textual analysis. The original goal of the researchers was to conduct a sentiment analysis based on the comments and the results of the survey. However, with the limited number of open-ended responses, the study was limited to only a descriptive and qualitative analysis of the textual data. The textual data was then analyzed using various libraries and functions of the Python programming language. Firstly, all punctuation from the data was removed to improve processing. Additionally, all the words were reduced to lower case to maintain consistency and further tokenized into individual features. Stopwords were removed from the textual data to eliminate superfluous words that had a minimal contribution to the textual analysis. Finally, the textual data was lemmatized to improve the comprehensibility of the data. Lemmatization is a process where words are reduced to a root word, such as the word *better* would be reduced to the word *good*. Lemmatization was preferred over stemming due to improved accuracy and domain understanding of the subject.

Once the textual data was processed, a Word Cloud was developed. Based on the initial Word Cloud, the researchers added more stopwords to reduce superfluous words from the generated Word Cloud. Words such as “against”, “other”, “or”, “reason”, listed”, “student”, “safety”, “flight”, “department”, and “feel” were added to the stop words list. Figure 5 was the generated Word Cloud from the textual data. Table 7 displays the frequency and relative frequency of words with a relative frequency of more than 0.5.

Figure 5
Word cloud from textual data.

Table 7
Frequency of Words in the Textual Data

Word	Frequency	Relative Frequency
Fatigue	33	1.0
Ground	30	0.909
Sick	19	0.576
No-Show	18	0.545
Training	18	0.545

Note. The word "Ground" refers to the grounding policy for students. Only words with a relative frequency of more than 0.50 and not included in the stop words are included in this table.

Qualitative Analysis for Perceived Risks

A qualitative analysis was conducted to capture relevant and recurring themes in the data. Phenomenological reduction, bracketing, and composite textual and structural description procedures were applied for qualitative analysis. The researchers read the comments and manually coded sentiments to identify themes. Three significant themes regarding perceived safety risks were captured from the data.

Medical Grounding and No Show Policy

The Medical Grounding and No Show Policy was the most recurring theme in the textual data. Respondents had a negative sentiment regarding a recently implemented policy. The "No Show Policy" changes were reviewed using the SMS risk assessment process, and no increase in risk severity and probability was found. Nonetheless, we recommend further studies on the impact of this "No Show Policy" on flight students' perceptions of safety culture.

Information Sharing and Communication

Information sharing and communication was theme evaluated in 13 comments. The findings supported that some students feel that communication regarding safety incidents and accidents could be improved. Effective safety communication is vital for a sound safety culture. "The free exchange of safety information, across all areas and through all levels, both vertically and horizontally, is actively promoted by management and facilitated by mechanisms and processes" (Ayres Jr. et al., 2009, p. 156).

Multi-cultural Operations

Multi-cultural operations was a theme evaluated in four comments. The findings supported that some students feel that a language barrier due to a multi-cultural environment could affect their perceptions of safety as suggested by the International Civil Aviation Organization (ICAO, 2002). Part 141 flight training organizations are increasingly and steadily becoming multicultural. Individuals from different nations may be paired in the cockpit, and language barriers may disrupt effective communication.

Thematic Analysis

The qualitative data analytics procedures described in this paper were intended to gather better insight into the sentiments of the respondents regarding the organization's safety culture. The qualitative analysis utilized a phenomenological framework that allowed the respondents to share their lived experiences in the specified area of study. A significant theme identified from the responses focused on policy making in the organization, specifically related to a “no show” policy. These results supported previous research in the literature review and the SEM model that highlighted the role of policy-making in an organization having a significant impact on safety awareness and culture. Additionally, the theme of information sharing in improving safety culture supported the need for management to share data, trends, and policy changes with employees to improve trust and accountability. The results of the qualitative data were coherent with the SEM analysis and previous literature on the subject; however, it adds to the literature on incorporating a robust safety culture in a flight training environment through an increased focus on policy-making and better-informed communication from management.

Discussions and Conclusions

The overall purpose of this study was to investigate flight students’ perceived safety culture at a Title 14 Code of Federal Regulations (CFR) Part 141 flight training school in the Southeast region of the United States. The results suggested a direct and strong predictive relationship between safety culture in collegiate flight training and the perceptions of respondents of the safety value and safety personnel multidimensional constructs of safety culture. Based on the operational definition of the constructs, Safety Personnel and Safety Values were directly related to the policy, objectives, and actions of the management of the Flight Department. While 81% (n=322) of students had never submitted a safety report, and only 3% (n=11) had submitted three or more safety reports, this could be attributed to the fact that 97% of flights are conducted with a flight instructor on board.

The textual data was used to analyze the impact of Safety Values and Safety Personnel on students' perceptions. Findings indicated that students have positive sentiments regarding the organizational safety values of the Flight Department. While the qualitative analysis highlighted some negative sentiments regarding specific policies, especially the No-Show policy, the overall safety culture and awareness for students are positively influenced by the safety values instilled by management and safety personnel. Respondents' feedback can be utilized to modify policies and to improve the safety culture and communication.

Researchers acknowledged that there are limitations to this study. For example, the narrow band of age and flight experience, as well as the sample size, will not make the results generic to other aviation professionals outside that domain. Psychosocial and other human factors such as stress, family issues, workload, and organizational pressures may have biased the opinions of respondents. Only 24% of the respondents were international students. Additionally, only 10% of them were CFIs.

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