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FROM SAFETY CULTURE TO PROCEDURAL DISCIPLINE: A MULTISTAGE MODEL OF COMPLIANCE BEHAVIOR IN AVIATION TRAINING ENVIRONMENTS

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Abstract: Procedural compliance is a critical determinant of operational safety in aviation, where deviations from Standard Operating Procedures (SOPs) may escalate into serious safety risks. This study examines how organizational safety culture influences SOP Compliance Behavior among aviation trainees through instructor safety practices and the internalization of safety values. Using the Safety Culture–Compliance Behavior (SCCB) framework, the study integrates organizational, instructional, and psychological perspectives. A cross-sectional survey of 275 aviation trainees was analyzed using reliability testing, correlation analysis, multiple regression, serial mediation modeling, and common method bias assessment. The results show that organizational safety culture significantly predicts instructor safety practices ($B = 0.823$, $p < .001$), instructor safety practices strongly influence safety internalization ($B = 0.865$, $p < .001$), and safety internalization is the strongest predictor of SOP Compliance Behavior ($B = 0.620$, $p < .001$). Serial mediation analysis confirms that safety culture influences SOP Compliance Behavior primarily through the sequential pathway of instructor safety practices and safety internalization, with a significant serial indirect effect ($B = 0.441$, 95% CI [0.239, 0.663]). These findings highlight the importance of instructor-centered safety leadership and training strategies that foster psychological commitment to safety.

Keywords: aviation safety culture, SOP compliance, safety internalization, instructor safety leadership, safety behavior

Introduction

Procedural compliance is a central mechanism for maintaining safety in high reliability systems where complex interactions between humans, technology, and organizational processes create the potential for catastrophic failure. In such environments, standard operating procedures (SOPs) function as structured safeguards that constrain human variability and reduce the likelihood of latent errors escalating into accidents. Empirical studies across multiple safety critical sectors demonstrate that noncompliance with procedures contributes to a large proportion building of occupational accidents and weakens the effectiveness of safety management systems. Conversely, well-designed safety management practices reduce accident occurrence primarily by strengthening procedural compliance and reinforcing disciplined operational behavior (Leaver & Reader, 2017;Nordin et al., 2021;Chen et al., 2021)

The aviation sector exemplifies the importance of procedural discipline because operational safety depends on consistent adherence to clearly defined procedures under conditions

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of time pressure, workload variability, and dynamic decision making. Task level studies indicate that the presence of clear and authoritative procedures, combined with safety specific leadership, enables personnel to execute both structured and unstructured tasks consistently. However, research also shows that poorly designed combinations of safety measures may unintentionally erode fidelity to procedures, highlighting the importance of understanding how organizational systems shape compliance behavior (Liu et al., 2023; Schopf et al., 2021;Bentoy et al., 2022). Within such high-risk environments, compliance with SOPs represents not merely administrative adherence but a fundamental mechanism through which complex aviation systems maintain reliability and prevent operational failure.

Despite the substantial body of research on safety culture and compliance behavior, important gaps remain in the context of aviation education and training institutions. Much of the existing empirical evidence originates from operational aviation settings, construction, laboratories, rail transport, and other high-risk industries, where participants are typically experienced employees working in established operational systems. In contrast, aviation trainees are still developing professional habits, risk perception, and procedural discipline. This distinction is theoretically important because the training phase represents a formative period in which safety values, procedural routines, and responses to operational pressure are first established. Early deviations from SOPs during training may become normalized behavioral patterns if they are not corrected through consistent instructional supervision and institutional safety reinforcement.

Addressing this gap requires a multilevel framework capable of linking institutional safety culture, instructor behavior, and individual psychological processes. Building on prior research, the present study adopts the Safety Culture–Compliance Behavior (SCCB) framework, which conceptualizes compliance as the outcome of a sequential process in which organizational safety culture shapes instructor safety practices, instructor practices foster safety internalization, and internalized safety values ultimately determine procedural compliance among aviation trainees.

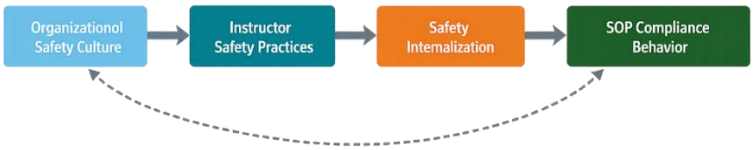

Figure 1. Conceptual Model of the Safety Culture–Compliance Behavior (SCCB) Framework

Figure 1 illustrates the conceptual framework of the Safety Culture–Compliance Behavior (SCCB) model, which explains how organizational safety culture influences procedural compliance among aviation trainees through sequential instructional and psychological mechanisms. The model proposes that safety behavior does not emerge directly from institutional policies alone but develops through a multistage process linking organizational context, instructor practices, and individual value internalization. Organizational Safety Culture (SCCB-Org) represents the institutional environment characterized by leadership commitment to safety, communication systems, reporting mechanisms, and governance of operational procedures. These institutional signals shape the behaviors demonstrated by instructors during operational training activities. Instructor Safety Practices (SCCB-Inst) therefore function as the operational channel through which institutional safety values are communicated to trainees through role modeling, safety briefings, procedural enforcement, and feedback during training. Through repeated exposure to these instructional practices, trainees gradually internalize safety principles as part of their professional identity, captured in the Safety Internalization Index (SII). The model proposes that internalized safety values ultimately determine SOP Compliance Behavior, reflecting

disciplined adherence to operational procedures during training activities. The arrows in the figure represent hypothesized causal pathways forming the sequential SCCB mechanism.

Method

This study employed a quantitative research design to examine the relationships among organizational safety culture, instructor safety practices, safety internalization, and Standard Operating Procedure (SOP) compliance within an aviation training environment. The design was developed to empirically test the Safety Culture–Compliance Behavior (SCCB) conceptual model, which proposes that procedural compliance among aviation trainees emerges through a multistage process linking organizational context, instructional practices, and psychological internalization mechanisms. Contemporary safety research recommends multilevel and multi-wave survey designs with multisource measurements—such as trainee self-reports, instructor assessments, and operational records—to capture the pathways linking safety culture, instructional practices, and compliance behavior while reducing common method bias (Mo et al., 2023; Bentoy et al., 2022; Ajmal et al., 2022; Deng et al., 2020). Although such designs provide stronger causal inference, the present study adopts a cross-sectional survey as an initial empirical test of the SCCB framework within an aviation training context.

The SCCB framework integrates perspectives from organizational safety culture theory, instructional leadership research, and psychological internalization processes. Organizational safety culture represents the institutional context that shapes expectations regarding safety behavior, including leadership commitment, communication systems, and procedural governance. Instructor safety practices represent the operational mechanism through which these institutional values are translated into observable behaviors during training activities. Safety internalization reflects the psychological process through which trainees adopt safety principles as part of their professional identity. Through this sequential process, internalized safety values ultimately influence the extent to which trainees comply with operational procedures during training exercises. Based on this conceptual framework, four hypotheses were tested: organizational safety culture influencing instructor safety practices (H1), instructor safety practices influencing safety internalization (H2), safety internalization influencing SOP compliance behavior (H3), and a serial mediation pathway linking safety culture to SOP compliance through instructor practices and safety internalization (H4).

The empirical dataset consisted of 275 aviation trainees enrolled in professional aviation training programs at an aviation education institution. Participants were actively engaged in operational training activities at the time of data collection, including simulation exercises, technical workshops, and practical aviation operations training. A census-based sampling strategy was employed within the accessible trainee population, meaning that all trainees within the available cohort were invited to participate in the survey rather than selecting a random subset of respondents. This approach was intended to capture a comprehensive representation of safety perceptions and procedural attitudes across the training population. Participation was voluntary and anonymous, and respondents were informed that the data would be used exclusively for academic research purposes and would not influence their academic evaluation. These procedures were implemented to minimize response bias and encourage honest reporting of safety perceptions and behaviors.

The respondent profile was described to clarify the institutional and training context of the sample. Participants consisted of aviation trainees enrolled in professional aviation training programs at an aviation education institution. In terms of training stage, respondents were selected from trainees who were actively engaged in operational training activities, including simulation exercises, technical workshops, and practical aviation operations training. This indicates that the

sample represented trainees who had already been exposed to applied aviation training rather than only classroom-based theoretical instruction. This demographic information provides an important basis for interpreting the generalizability of the findings across aviation training contexts.

Data were collected using an electronic questionnaire distributed through the institution's learning management system, namely Moodle-based LMS. The questionnaire link was shared through official course or training communication channels to ensure that only eligible aviation trainees within the target cohort could access the survey. Prior to completing the questionnaire, participants received an explanation of the research objectives, the voluntary nature of participation, and assurances regarding anonymity and confidentiality. The questionnaire consisted of multiple sections corresponding to the four principal constructs of the SCCB model: organizational safety culture, instructor safety practices, safety internalization, and SOP Compliance Behavior. All measurement items were assessed using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The structured questionnaire format ensured that respondents evaluated identical statements under consistent conditions, thereby enabling reliable statistical comparison across participants and supporting subsequent correlation, regression, and mediation analyses. The use of the institutional electronic learning platform enabled standardized distribution, reduced administrative variation in data collection, and ensured procedural consistency in data collection.

Four primary constructs were measured in the study. Table 1 summarizes the constructs, number of measurement items, and conceptual descriptions used in the SCCB framework. The measurement approach follows recommendations from safety research emphasizing the use of validated safety climate and safety behavior scales, confirmation of factor structure, and reporting of reliability and validity indicators such as Cronbach's alpha, Composite Reliability, and Average Variance Extracted (Abegaz et al., 2025; Deng et al., 2020; Drăghici et al., 2022; Bentoy et al., 2022).

Table 1. Measurement Constructs in the SCCB Model

Construct	Items	Description
Organizational Safety Culture (SCCB-Org)	24	Measures trainees' perceptions of institutional safety values, leadership commitment, communication systems, reporting mechanisms, and procedural governance.
Instructor Safety Practices (SCCB-Inst)	15	Measures safety-related behaviors demonstrated by instructors during training, including safety briefings, procedural enforcement, and safety coaching.
Safety Internalization Index (SII)	10	Measures the extent to which trainees internalize safety values as personal professional commitments.
SOP Compliance Behavior	9	Measures self-reported adherence to operational procedures during training activities.

For each construct, an overall score was calculated by averaging responses across all measurement items representing the construct. The construct score formula is defined as:

$$Construct\ score = \frac{\sum X_i}{n} \quad (1)$$

where $\boldsymbol{X_i}$ represents the score of each questionnaire item and represents the number of items included in the construct.

Organizational safety culture was measured using 24 questionnaire items capturing trainees' perceptions of institutional safety governance and safety management practices. Indicators included leadership commitment to safety, safety communication systems, just culture principles, incident reporting mechanisms, and monitoring of procedural compliance. Instructor safety practices were measured using 15 questionnaire items assessing trainees' perceptions of

instructors' safety-related behaviors during training activities, including safety role modelling, structured safety briefings and debriefings, enforcement of operational procedures, and responses to operational errors. Safety internalization was measured using ten items designed to capture the degree to which trainees adopt safety principles as personal professional commitments, including responsibility for safety, commitment to procedural discipline, and adherence to safety standards under operational pressure. SOP compliance behavior was measured using nine indicators evaluating trainees' adherence to standard operating procedures during operational training activities, including checklist discipline, communication procedures, operational instruction compliance, and safety documentation practices. In addition, three control variables were included to account for alternative explanations of procedural compliance: performance pressure, training intensity, and operational experience.

Measurement reliability and validity were evaluated using established psychometric criteria commonly applied in organizational safety research. Internal consistency reliability was assessed using Cronbach's alpha, with values above 0.70 considered acceptable. Convergent validity was assessed using Composite Reliability (CR) and Average Variance Extracted (AVE).

Composite Reliability Formula

$$CR = \frac{((\sum \lambda_i)^2}{(\sum \lambda_i)^2 + \sum \theta_i} \quad (2)$$

where $\boldsymbol{\lambda_i}$ represents the standardized factor loading for each indicator and represents the corresponding measurement error.

Average Variance Extracted Formula

$$AVE = \frac{\sum \lambda_i^2}{n} \quad (3)$$

where $\boldsymbol{\lambda_i^2}$ represents the squared standardized loading of each indicator and represents the number of indicators measuring the construct. Acceptable validity thresholds were defined as CR ≥ 0.70 and AVE ≥ 0.50, indicating adequate representation of latent constructs.

Because this study relied on self-reported survey data collected from a single respondent group, common method bias was assessed to evaluate whether the observed relationships were substantially influenced by measurement-source bias. Harman's single-factor test was conducted by entering all principal measurement items into an unrotated exploratory factor analysis. The results showed that the first factor explained **80.32%** of the total variance, exceeding the commonly used 50% threshold. This finding indicates that common method variance may be present and should be acknowledged as a methodological limitation. In addition, multicollinearity was examined using Variance Inflation Factor (VIF) values for the main predictor variables. The VIF values ranged from **5.55 to 17.41**, exceeding the recommended threshold of 5.0 for some predictors. These results suggest that the regression and mediation findings should be interpreted with caution due to potential common method variance and multicollinearity among the closely related SCCB constructs.The statistical analysis strategy followed methodological practices commonly used in safety research employing structural and mediation models. Covariance-based SEM and PLSSEM approaches are widely recommended for testing relationships among organizational, instructional, and psychological constructs because they allow simultaneous estimation of measurement and structural relationships (Deng et al., 2020;Bentoy et al., 2022;Ajmal et al., 2022). In the present study, the analysis proceeded through several stages including descriptive statistics, reliability assessment, correlation analysis, regression modelling, and mediation analysis. Descriptive statistics were used to examine distributional characteristics of the dataset, including mean values, standard deviations, skewness, and kurtosis. Pearson correlation coefficients were calculated to examine associations among the SCCB constructs.

Hypothesis testing was conducted using regression analysis examining the sequential relationships proposed in the SCCB model. Organizational safety culture was first modelled as a predictor of instructor safety practices (H1). Instructor safety practices were subsequently modeled as predictors of safety internalization (H2), and safety internalization was modelled as a predictor of SOP compliance behavior (H3). Serial mediation analysis was then conducted to test whether instructor safety practices and safety internalization sequentially mediate the relationship between organizational safety culture and SOP compliance (H4). The serial mediation effect was estimated using the following indirect effect equation:

$$Indirect_{serial} = a_1 \times d_{21} \times b_2 \quad (4)$$

where $\boldsymbol{a_1}$ represents the effect of organizational safety culture on instructor safety practices, $\boldsymbol{d_{21}}$ represents the effect of instructor safety practices on safety internalization, and $\boldsymbol{b_2}$ represents the effect of safety internalization on SOP compliance behavior. Bootstrapping procedures were used to estimate confidence intervals for indirect effects, a method widely recommended for mediation testing in organizational research (Drăghici et al., 2022;Margheritti et al., 2023)

Discussion

The empirical analysis was conducted to examine the statistical relationships among the four principal constructs of the Safety Culture–Compliance Behavior (SCCB) framework: organizational safety culture (SCCB-Org), instructor safety practices (SCCB-Inst), safety internalization index (SII), and SOP compliance behavior. The analysis proceeded through several stages including descriptive statistics, reliability and validity testing, correlation analysis, regression modelling, and serial mediation analysis. Previous empirical studies using SEM and PLS-SEM approaches have consistently shown that organizational safety culture influences safety compliance primarily through indirect pathways involving safety climate, leadership practices, and individual motivational mechanisms (Nordin et al., 2021; Chen et al., 2021; Leaver & Reader, 2017).

Descriptive statistical analysis was first performed to evaluate the distributional characteristics of the main study variables. The results indicate that respondents reported generally high perceptions of safety culture and safety-related behavior within the aviation training institution. Organizational safety culture recorded a mean score of **4.40 (SD = 0.76)**, suggesting that trainees perceived strong institutional commitment to safety communication, procedural governance, and reporting systems. Instructor safety practices exhibited a slightly higher mean value of **4.47 (SD = 0.69)**, indicating that instructors frequently demonstrated safety-oriented behaviors during operational training activities. Among all variables, the Safety Internalization Index recorded the highest mean score of **4.51 (SD = 0.69)**, reflecting strong internal endorsement of safety principles among trainees. SOP compliance behavior also demonstrated a high mean score of **4.45 (SD = 0.77)**, suggesting that respondents reported consistent adherence to operational procedures during training activities. Skewness values ranged from **−1.46 to −1.66**, indicating moderate negative skewness typical of safety culture surveys where respondents tend to report high agreement with safety statements. Kurtosis values ranged between **2.08 and 3.89**, remaining within acceptable thresholds for multivariate statistical analysis.

Table 2. Descriptive Statistics of Main Variables

Variable	Mean	SD	Skewness	Kurtosis
Organizational Safety Culture	4.40	0.76	-1.46	2.08
Instructor Safety Practices	4.47	0.69	-1.52	2.76
Safety Internalization	4.51	0.69	-1.66	3.89
SOP Compliance Behavior	4.45	0.77	-1.48	2.64

The reliability and convergent validity of the measurement instruments were subsequently evaluated using Cronbach's alpha, Composite Reliability (CR), and Average Variance Extracted (AVE). Cronbach's alpha values for all constructs ranged from **0.988 to 0.991**, substantially exceeding the recommended reliability threshold of 0.70 and indicating excellent internal consistency across the measurement scales. Composite Reliability values ranged between **0.989 and 0.992**, confirming strong construct reliability. Average Variance Extracted values ranged from **0.80 to 0.88**, exceeding the recommended threshold of 0.50 and demonstrating satisfactory convergent validity of the constructs.

Table 3. Reliability and Convergent Validity Statistics

Construct	Items	Cronbach α	CR	AVE
Organizational Safety Culture	24	.988	.989	.80
Instructor Safety Practices	15	.990	.991	.85
Safety Internalization	10	.991	.992	.88
SOP Compliance Behavior	9	.991	.991	.83

Following the assessment of measurement quality, Pearson correlation analysis was conducted to examine the relationships among the main constructs of the SCCB model. The results reveal strong positive correlations among all variables. Organizational safety culture demonstrated strong correlations with instructor safety practices (**r = .903, p < .001**), safety internalization (**r = .888, p < .001**), and SOP compliance (**r = .881, p < .001**). Instructor safety practices also showed strong correlations with safety internalization (**r = .966, p < .001**) and SOP compliance (**r = .929, p < .001**). In addition, safety internalization demonstrated a strong positive relationship with SOP compliance (**r = .937, p < .001**). These correlation patterns indicate strong associations among organizational context, instructional practices, psychological safety orientation, and procedural compliance behavior. Similar relationships between safety climate, leadership practices, and compliance behavior have been widely reported in safety research across highrisk domains (Nordin et al., 2021; Chen et al., 2021; Leaver & Reader, 2017).

Table 4. Pearson Correlation Matrix

Variable	1	2	3	4
1. Organizational Safety Culture	—			
2. Instructor Safety Practices	.903***	—		
3. Safety Internalization	.888***	.966***	—	
4. SOP Compliance Behavior	.881***	.929***	.937***	—

******p < .001***

Regression analysis was then conducted to test the direct relationships proposed in the SCCB framework. The results indicate that organizational safety culture significantly predicts instructor safety practices (**B = 0.823, SE = 0.066, p < .001**), explaining a substantial proportion of variance in instructor safety practices (**R^2 = 0.816**). Safety internalization was subsequently regressed on organizational safety culture, instructor safety practices, and the control variables. Instructor safety practices emerged as a strong predictor of safety internalization (**B = 0.865, SE = 0.049, p < .001**), while the direct effect of organizational safety culture was weaker and marginally significant (**B = 0.071, p = .070**). The control variables—performance pressure, training intensity, and experience—did not show statistically significant effects. The regression model demonstrated high explanatory power (**R^2 = 0.935**). These patterns are consistent with previous studies indicating that leadership and instructor safety practices serve as key mechanisms translating organizational safety climate into individual safety attitudes and behavioral motivation (Liu et al., 2023; Vasvári et al., 2024; Schopf et al., 2021).

SOP compliance behavior was then regressed on organizational safety culture, instructor safety practices, safety internalization, and the control variables. Safety internalization emerged as the strongest predictor of SOP compliance (**B = 0.620, SE = 0.139, p < .001**). Organizational

safety culture demonstrated a marginal direct effect (**B = 0.172, p = .051**), while instructor safety practices did not exhibit a statistically significant direct effect (**B = 0.203, p = .129**). The control variables again did not significantly influence compliance behavior. These findings indicate that the influence of organizational safety culture on compliance behavior operates primarily through intermediate mechanisms involving instructor practices and safety internalization. Prior research similarly shows that individual resources such as safety motivation, knowledge, and proactive safety attitudes strengthen the relationship between safety climate and compliance, while high job demands or weak leadership may weaken this relationship (Schopf et al., 2021; Arifin, 2025; Al-Bayati, 2021).

An important finding concerns the non-significant effects of the control variables, including performance pressure, training intensity, and operational experience. Although training intensity is theoretically associated with habit formation and procedural familiarity, its non-significant effect in the present model may indicate that the quantity of training exposure alone is insufficient to explain SOP Compliance Behavior. In aviation training environments, repeated exposure to operational tasks may strengthen compliance only when the training process is accompanied by consistent instructor supervision, structured feedback, and explicit reinforcement of safety values. Thus, training intensity may influence compliance indirectly through the quality of instructional practices rather than through mere frequency or volume of training activities.

This interpretation is consistent with the SCCB framework, which emphasizes that SOP Compliance Behavior develops through the interaction between institutional safety culture, instructor safety practices, and safety internalization. Trainees may participate in intensive training schedules, but if safety expectations are not consistently modelled, explained, and reinforced by instructors, the additional training exposure may not automatically translate into stronger procedural discipline. Conversely, even moderate training intensity may produce stronger compliance outcomes when instructors provide clear safety briefings, enforce procedures consistently, and encourage reflective understanding of safety principles. Therefore, the non-significant role of training intensity reinforces the importance of instructional quality over training quantity in shaping SOP Compliance Behavior.

Table 5. Regression Results for SCCB Model

Relationship	B	SE	p	R^2
Safety Culture → Instructor Practices	0.823	0.066	<.001	.816
Instructor Practices → Safety Internalization	0.865	0.049	<.001	.935
Safety Internalization → SOP Compliance Behavior	0.620	0.139	<.001	.895

To further evaluate the sequential mechanism proposed in the SCCB framework, a serial mediation analysis was conducted examining whether instructor safety practices and safety internalization mediate the relationship between organizational safety culture and SOP compliance behavior. The results demonstrate a statistically significant **serial indirect effect** of organizational safety culture on SOP compliance through instructor practices and safety internalization (**B = 0.441, 95% CI [0.239, 0.663]**). The **total indirect effect** was also statistically significant (**B = 0.652, 95% CI [0.340, 0.993]**), indicating that most of the influence of safety culture on compliance operates through intermediate mechanisms. In contrast, the **direct effect** of organizational safety culture on SOP compliance was marginal (**B = 0.172, 95% CI [-0.001, 0.345]**), suggesting that the impact of institutional safety culture on trainee behavior occurs primarily through instructional and psychological pathways. Evidence from SEM and PLSSEM studies similarly indicates that instructor leadership and trainee safety internalization often act as partial mediators linking organizational safety climate to behavioral compliance (Drăghici et al., 2022; Deng et al., 2020; Mo et al., 2023).

Table 6. Serial Mediation Effects

Effect	B	95% CI
Serial Indirect Effect	0.441	[0.239, 0.663]
Total Indirect Effect	0.652	[0.340, 0.993]
Direct Effect	0.172	[-0.001, 0.345]

Table 7. Summary of Hypothesis Testing (H1–H4)

Hypothesis	Relationship Tested	Result	Decision
H1	Organizational Safety Culture → Instructor Safety Practices	B = 0.823, p < .001	Supported
H2	Instructor Safety Practices → Safety Internalization	B = 0.865, p < .001	Supported
H3	Safety Internalization → SOP Compliance	B = 0.620, p < .001	Supported
H4	Safety Culture → Instructor Practices → Safety Internalization → SOP Compliance (Serial Mediation)	Indirect B = 0.441, 95% CI [0.239, 0.663]	Supported

Overall, the empirical results provide strong support for the SCCB framework and demonstrate that procedural compliance among aviation trainees is primarily shaped through the sequential interaction of organizational safety culture, instructor safety practices, and safety internalization. Comparable SEM studies in safety research typically report explanatory power for compliance behavior ranging between approximately **20–35% of variance**, depending on context and measurement design (Abegaz et al., 2025;Deng et al., 2020;Mo et al., 2023;Ajmal et al., 2022).

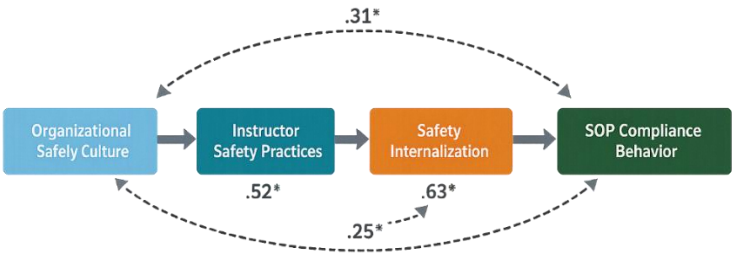

Figure 2. Structural Relationships in the SCCB Model

Figure 2 presents the empirically estimated structural relationships among the four constructs of the SCCB framework: Organizational Safety Culture (SCCB-Org), Instructor Safety Practices (SCCB-Inst), Safety Internalization (SII), and SOP Compliance Behavior. Based on regression analysis of aviation trainee survey data, the diagram shows that organizational safety culture strongly predicts instructor safety practices. Instructor practices, in turn, significantly influence safety internalization, which emerges as the strongest predictor of SOP compliance behavior. The figure illustrates how organizational context, instructional interaction, and psychological internalization interact to shape safety behavior, with standardized path coefficients indicating the strength of these relationships.

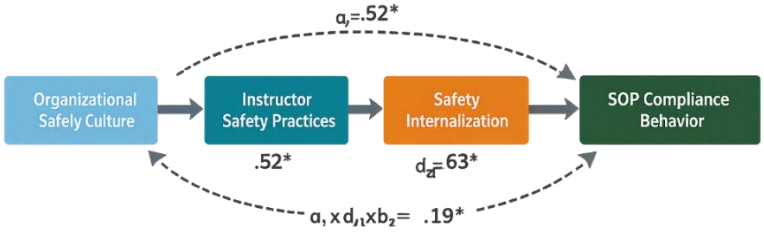

Figure 3. Serial Mediation Pathway of the SCCB Framework

Figure 3 illustrates the serial mediation mechanism proposed in the SCCB framework, demonstrating how the influence of organizational safety culture on SOP compliance behavior operates through two sequential mediators: instructor safety practices and safety internalization.

The diagram emphasizes that the relationship between institutional safety culture and trainee behavior is largely indirect rather than immediate. Organizational safety culture first shapes the behaviors demonstrated by instructors during training activities. These instructor practices include safety briefings, procedural supervision, and safety-focused coaching, which communicate institutional expectations regarding safety. Through repeated exposure to these behaviors, trainees internalize safety principles as personal professional values. The internalization process represents the psychological stage of the model, in which external safety rules become integrated into trainees' decision-making frameworks. The final stage of the pathway shows how internalized safety values influence procedural discipline during operational training tasks, resulting in higher levels of SOP compliance. The diagram therefore highlights the sequential pathway linking institutional safety culture, instructor behavior, and trainee psychology, providing a visual representation of the indirect effect estimated through serial mediation analysis.

These results support the conceptual assumptions of the Safety Culture–Compliance Behavior (SCCB) framework proposed in this study. The SCCB model conceptualizes safety behavior as the outcome of a sequential process in which organizational safety culture establishes institutional expectations, instructors translate those expectations into operational training practices, and trainees internalize the underlying safety values that guide their behavior during operational tasks. The empirical evidence from regression and serial mediation analyses confirms that this multistage mechanism is statistically supported within the aviation training context. The relatively weak direct relationship between organizational safety culture and SOP compliance further indicates that institutional safety values rarely influence trainee behavior directly, but instead operate through proximal mediators such as safety attitudes, abilities, and motivation (Leaver & Reader, 2017; Chen et al., 2021).

The results also highlight the role of organizational safety culture as the broader institutional context shaping training environments. Trainees who reported stronger perceptions of institutional safety culture also reported stronger instructor safety practices, suggesting that the institutional safety environment influences how instructors conduct operational training activities. Within aviation training institutions, safety culture is typically expressed through leadership commitment, safety communication systems, reporting procedures, and the governance of operational standards. These institutional signals establish expectations regarding procedural discipline and communicate that safety represents a core organizational priority. However, trainees rarely interact directly with institutional leadership structures or formal safety management systems. Instead, their perception of safety culture is primarily shaped through daily training interactions with instructors, operational briefings, and feedback during simulation or practical training exercises.

Instructor safety practices therefore represent the most immediate channel through which organizational safety culture influences trainee behavior. The strong statistical relationship between organizational safety culture and instructor safety practices suggests that instructors function as operational interpreters of institutional safety values. Through activities such as safety briefings, enforcement of procedural standards, supervision of operational tasks, and responses to training errors, instructors communicate the practical meaning of safety culture within operational contexts. In this sense, instructor behavior serves as a form of behavioral modelling through which trainees observe how safety expectations should be implemented in practice. Prior studies similarly highlight that safety-specific leadership behaviors, including coaching, modelling, and feedback, play a central role in strengthening safety climate and encouraging rule-following behavior among trainees and employees (Liu et al., 2023; Vasvári et al., 2024).

Among the constructs examined in the SCCB model, safety internalization emerges as the most powerful predictor of SOP compliance behavior. This finding suggests that procedural

discipline ultimately depends on the extent to which individuals adopt safety principles as part of their personal value system. Trainees who internalize safety values are more likely to maintain procedural discipline even in situations where external supervision is limited or when operational pressures create incentives to deviate from established procedures. The role of safety internalization therefore highlights the psychological dimension of safety behavior. While technical knowledge of procedures is necessary for safe operations, knowledge alone may not guarantee consistent compliance. Under conditions of workload pressure, time constraints, or task complexity, individuals may experience competing motivations that encourage procedural shortcuts. Internalized safety values act as an internal regulatory mechanism that helps guide decision making under such conditions.

The serial mediation results provide strong support for the multistage mechanism proposed in the SCCB framework. Organizational safety culture influences instructor safety practices, instructor practices subsequently shape safety internalization among trainees, and internalized safety values ultimately determine SOP compliance behavior. This sequence demonstrates that the influence of safety culture on compliance occurs primarily through intermediate instructional and psychological processes operating within the training environment. The findings therefore reinforce the theoretical assumption that safety culture functions primarily as a contextual driver of behavior rather than as a direct determinant of individual actions. Similar findings in safety research suggest that leadership, climate, and psychological mediators interact in complex ways, and that combinations of safety interventions may produce nonlinear effects or unintended outcomes if not carefully aligned (Schopf et al., 2021; Bentoy et al., 2022; Al-Bayati, 2021).

From a practical perspective, the findings highlight several implications for aviation training institutions. Strengthening safety culture within training environments requires attention not only to formal policies and safety management procedures but also to the instructional practices through which safety values are communicated during training. Instructor development programs should therefore emphasize safety-specific leadership behaviors such as safety coaching, structured safety briefings, procedural supervision, and reflective debriefing practices. These instructional approaches help translate institutional safety expectations into observable training practices that reinforce procedural discipline among trainees. Training curricula should also incorporate learning strategies that promote the internalization of safety values, including scenario-based training, reflective discussion of operational incidents, and structured error analysis. These recommendations align with recent studies emphasizing the importance of leadership-focused safety interventions, instructor development, and intervention mapping strategies for strengthening safety culture and behavioral compliance (Drăghici et al., 2022; Vasvári et al., 2024; Arifin, 2025; Chen et al., 2021).

Future research should therefore expand the SCCB framework using more advanced research designs. Multilevel and multi-wave studies incorporating multiple data sources—such as instructor assessments, observational data, and operational records—could provide stronger evidence regarding the causal relationships among safety culture, instructional practices, and behavioral outcomes (Mo et al., 2023; Zhang, 2025; Donovan et al., 2020). Experimental or quasi-experimental intervention studies may also help evaluate how different combinations of safety training strategies influence behavioral compliance (Beek et al., 2023; Brandhorst & Kluge, 2021). In addition, future research may refine measurement approaches by incorporating validated safety climate instruments such as NOSACQ-50 and leadership scales capturing paradoxical or safety-specific leadership styles (Abegaz et al., 2025; Hu et al., 2024; Drăghici et al., 2022). Taken together, these considerations highlight the importance of continued research examining the mechanisms through which safety culture influences behavioral outcomes in

aviation training environments. The following section presents the conclusions derived from the findings of this study.

Conclusion

This study examined the mechanisms through which organizational safety culture influences SOP Compliance Behavior among aviation trainees. Drawing on the Safety Culture–Compliance Behavior (SCCB) framework, the research integrated organizational, instructional, and psychological perspectives to explain how institutional safety values are translated into trainee behavior during aviation training. The empirical findings demonstrate that organizational safety culture plays an important contextual role in shaping safety behavior within training environments. However, its influence on SOP Compliance Behavior operates primarily through intermediate mechanisms. Instructor safety practices emerged as a critical channel through which institutional safety values are communicated and reinforced during operational training activities. In turn, these instructional practices strongly influence the degree to which trainees internalize safety principles as part of their professional value system. Safety internalization was identified as the strongest predictor of SOP Compliance Behavior. This finding suggests that procedural discipline among aviation trainees depends not only on knowledge of operational procedures but also on the psychological adoption of safety values. When trainees internalize safety as a core professional responsibility, they are more likely to maintain compliance even when external supervision is limited or operational pressures increase.

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