

**SAFETY CULTURE IN A REGIONAL AIRLINE:
RESULTS FROM A COMMERCIAL AVIATION SAFETY SURVEY**

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The purpose of this study was to develop and initially validate a survey to assess safety culture within the commercial aviation industry. Based on our previous review of safety culture research, we identified five global components of safety culture including Organizational Commitment, Management Involvement, Employee Empowerment, Reward Systems, and Reporting Systems. We developed a survey to assess these cultural factors as they relate to pilots at a regional, FAR Part 135 scheduled air carrier. Our goal was to allow employees throughout the airline (from line pilot to top-level management) to give their personal assessment of these organizational factors, taking into account the operational constraints of the airline and its personnel. We targeted non-regulated organizational factors to help highlight possible areas of improvement in the airline. We also gathered feedback from the airline on the techniques employed by the survey to measure safety cultural factors. The results from this survey indicated positive overall airline performance in relation to organizational safety factors. However, specific factors revealed areas in need of organizational attention for improvement. These target issues included areas of vulnerability perceived by the pilots. The results also allowed us to refine our assessment instrument to improve its usability and validity. Future endeavors in this area will allow researchers to proactively pinpoint specific latent organizational factors in need of improvement that may be addressed to develop better patterns of organizational communication and overall safety.

Background

Numerous studies have been performed to define and assess safety culture in a variety of complex, high-risk industries. However, few formally documented efforts have been made to assess safety culture within the aviation industry. Pidgeon (1998) notes that empirical efforts to study the concept of safety culture have remained “unsystematic, fragmented, and in particular under specified in theoretical terms.” Thusly, we set out to synthesize research in this area, develop a metric to measure safety culture, and assess the extent to which key organizational features are consistent across time and situations.

Safety culture is commonly viewed as an enduring characteristic of an organization that is reflected in its consistent way of dealing with critical safety issues (Zhang et al., 2002). There are generally five global components or indicators of safety culture: Organizational Commitment, Management Involvement, Employee Empowerment, Reward Systems, and Reporting Systems (Wiegmann et al., 2002).

Organizational Commitment (OC) to safety refers to the extent to which upper-level management identifies safety as a core value or guiding principles of the organization (Dedobbeleer & Beland, 1991; Eiff, 1999; Fleming et al., 1996; Flin et al., 2000; Gordon et al., 1996; Meshkati, 1997; Yule et al., 2001; Zohar, 1980, 2000). An organization’s commitment to safety is therefore reflected in the ability of its upper-level management to demonstrate

an enduring, positive attitude toward safety, even in times of fiscal austerity, and to actively promote safety consistently across all levels within the organization.

Management Involvement (MI) refers to the extent to which both upper- and middle-level managers get personally involved in critical safety activities within the organization (Eiff, 1999). Management involvement in safety is reflected by managers’ presence and contribution to safety seminars and training, their active oversight of safety critical operations, their ability to “stay in touch” with the risks involved in everyday operations and the extent of good communication about safety issues, both up and down the organizational hierarchy.

A fair evaluation and **Reward System (REW)** is needed to promote safe behavior and discourage or correct unsafe behavior (Eiff, 1999). One of the key components of an organization’s safety culture is the manner in which both behaviors are evaluated and the consistency in which rewards or penalties are assigned according to evaluations (Reason, 1990).

Employee Empowerment (EE) refers to an individual’s perceptions or attitudes as a result of a delegation of authority or responsibility by upper-level management. An empowered attitude can lead to increased motivation to “make a difference,” to go beyond the call of duty for organizational safety and take responsibility for ensuring safe operations (Geller, 1994). Within the context of safety culture, this means that employees have a substantial voice in

safety decisions, have the leverage to initiate and achieve safety improvements, hold themselves and others accountable for their actions, and take pride in the safety record of their organization.

An effective and systematic **Reporting System (REP)** is the keystone to identifying the weakness and vulnerability of safety management before an accident occurs. The willingness and ability of an organization to proactively learn and adapt its operations based on incidents and near misses before an accident occurs is critical to improving safety (Eiff, 1999).

Survey Development

Organizational assessment can take many forms, such as safety audits, one-on-one interviews and observations, checklists, error reporting forms, or surveys distributed to all operational personnel. Each form of assessment has positive and negative factors relating to its use such as time, cost, need for specialized personnel, etc. The survey approach is one of the most commonly used methods to assess safety-critical factors of high-risk organizations. This approach allows access to a large distribution and broad cross section of the population. Respondents can remain anonymous and it allows for quick turnaround, with the outside party usually viewed as neutral, without regard for bias.

We identified questionnaire items in our previous investigation of the relevant organizational culture literature that could be used to measure the organizational dimensions of safety culture as it relates to flight operations (Wiegmann et al., 2001). A database of over 1000 items from various industries (transportation, oil, gas, mineral, nuclear, aviation, utilities and manufacturing) was created and grouped by dimension (Wiegmann et al., 2002). Redundant items were removed, items reworded to pertain to aviation, and consensus achieved to develop a survey assessing safety culture. The remaining items were then re-examined to remove similar items across categories. Remaining items were put into a survey format to include a 7-point Likert scale and an area for comments on each of the items identified. Subject matter experts supplied feedback regarding the items and their appropriateness to include in a survey of commercial airline pilots and management. Once their feedback was received, the items were revised, resulting in the 86-item, Commercial Aviation Safety Survey (CASS).

Method

Participants

One hundred eight Commercial Aviation Safety Surveys were distributed to 93 pilots and 15 management/supervisory personnel at a regional, FAR Part 135 scheduled air carrier. A copy of the survey was placed in each employee's mail folder where they receive their paycheck. A letter from senior management accompanied the survey, explaining the organizational and research purposes of the survey and encouraging employees to participate. We provided a stamped, addressed envelope for the participants to return the surveys, directly and anonymously, to the University of Illinois' Aviation Human Factors Division. Participation was voluntary, and no monies were paid to respondents.

Of the 108 surveys distributed, 43 (40%) were returned. All surveys returned were in usable condition and included in the analysis. Thirty-five respondents (81%) described their primary job responsibility as "Line Pilot", while six described their positions as "Manager/Supervisor" or "Other" and two declined to provide this information. We included a demographic section at the end of the survey to provide additional information. Most respondents (86%) were male, 7% female, and 7% did not provide gender information. The majority of respondents (56%) were between 31 and 50 years of age. Most (74%) had been employed by the airline between 1 and 10 years, with 59% indicating that they had held their present position for 5 years or fewer. Seventy percent of the respondents indicated that they had reported a safety problem at some point in their career at the airline.

Results

Scale Reliability

Guttman-Cronbach alpha coefficients derived from the airline's data for the five safety culture scales and two perceived risk scales are provided in Table 1. All seven scales meet or exceed generally accepted standards for reliability.

Table 1. Reliability of Survey Subscales

<u>Scale</u>	<u># of Items</u>	<u>Alpha</u>
Organizational Commitment	27	.94
Management Involvement	18	.90
Reward System	9	.71
Employee Empowerment	14	.81
Reporting System	13	.86

Item Level Analysis

Though the initial reliability of all five dimensions was acceptable, item-level analysis indicated that some items correlated only weakly or even negatively with other items in the scale. The correlation analysis indicated that scores on the five dimension scales were highly interrelated (Table 2).

While it was expected that some correlation would exist between the five dimensions of safety culture, the large size of the observed correlations suggests that the survey may have measured fewer distinct dimensions than intended. In particular, the correlation between the OC and MI scales is close to unity, implying that these two scales are actually measuring a single construct. In addition, the average inter-item correlation between OC and MI items was .35, while the average inter-item correlation among OC items was .34 and that between MI items .36. In other words, the OC items are approximately as closely related to the MI items as to one another.

While this suggests that MI and OC may be two names for the same basic construct, it is not possible at this time to draw a definitive conclusion from the available data. The small sample size (43

respondents) compared to the number of items in the survey precludes conducting a factor analysis to determine the structure of the data. In addition, the initial conceptual distinction between OC and MI was such that OC referred to the priority placed on safety by senior management, reflected in the policies of the organization as a whole, while MI referred to the personal involvement of supervisory-level managers in safety concerns. At this airline, the organization chart is relatively flat, so it is reasonable to expect that perceptions of top management and perceptions of one’s immediate supervisor would be highly similar. Further, the wording of the instructions in the survey was such as to encourage pilots to consider both senior management and their immediate supervisors whenever the word “management” was used. In a larger or more vertical organization, the distinction between MI and OC might become apparent. It remains plausible that supervisory-level managers’ personal involvement in safety could differ substantially from the safety commitment of the organization’s policy-makers. In light of these considerations, it seems appropriate to retain OC and MI as separate dimensions for the present and clarify the wording of these items for future use.

Dimension Scores

Performance scores for the airline on each of the five dimensions of safety culture were determined by calculating the mean of the participants’ responses to the items in each scale. Means for each dimension scale appear in Figure 1. Responses were given on a seven-point Likert scale, ranging from 1-“strongly disagree,” to 7-“strongly agree,” with 4 representing “neither agree nor disagree.” Negatively worded items were recoded before averaging so that higher scores on all items reflected a positive response.

Table 2. Interscale Correlations of the Dimensions of Safety Culture and Perceived Risk Factors.

<u>Scale</u>	<u>OC</u>	<u>MI</u>	<u>AS</u>	<u>EE</u>	<u>RS</u>	<u>OR</u>	<u>IR</u>
Organizational Commitment	1.00						
Management Involvement	.911	1.00					
Reward System	.643	.620	1.00				
Employee Empowerment	.745	.672	.690	1.00			
Reporting System	.796	.848	.440	.564	1.00		
Organizational Risk	-.569	-.569	-.559	-.493	-.402	1.00	
Individual Risk	-.005	-.042	.072	-.012	-.025	.147	1.00

Correlations in **bold** type are significantly different from zero (p< .01).

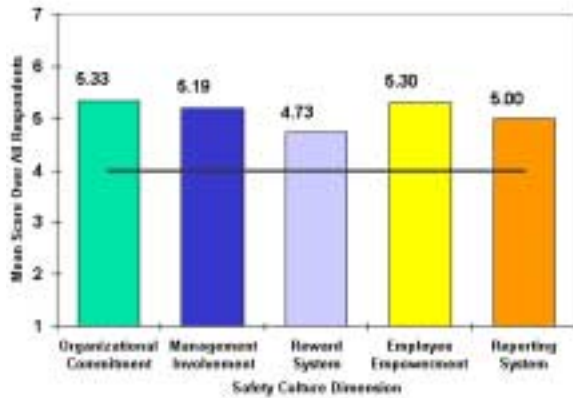


Figure 1. Mean airline scores on the five dimensions of safety culture. The horizontal line indicates the scale midpoint of 4.

The mean score for the airline on all five dimensions was above the neutral point, indicating that respondents hold a generally positive opinion of their airline’s safety culture in regard to each dimension (Table 3). However, considerable variability within most scales suggests that not all of these airline employees view the airline’s safety culture in the same light. No dimension received a perfect score from any employee (i.e., endorsing the appropriate “strongly agree/disagree” alternative for all items in the scale), and no dimension received a completely positive score from all employees. No individual employee gave negative scale scores for all five dimensions, and only one gave scale scores above 6 on all dimensions.

Table 3. Means and Ranges of Dimension Scores

Scale	Mean	Minimum	Maximum
Organizational Commitment	5.33	3.04	6.81
Management Involvement	5.19	1.88	6.83
Reward System	4.73	2.44	6.88
Employee Empowerment	5.30	3.64	6.86
Reporting System	5.00	3.00	6.46

Predicting Perceived Risk

We included four additional items to the survey to assess the respondent’s perceptions of the likelihood of an accident or incident. These measures were originally intended to constitute a single measure of perceived risk. Upon analysis, the pattern of correlations between the items indicated that the items could be divided into two distinct categories:

perceived organizational risk and perceived personal risk. The former items deal with the likelihood that the *airline* will be involved in an accident or incident, while the latter consider the probability that the *individual respondent* will be involved. The correlation between perceived organizational risk and personal risk is 0.15 and does not meet conventional criteria for statistical significance, which suggests that the two concepts are unrelated. Both scales demonstrate acceptable reliability, so it is appropriate to treat them as distinct measures.

In the context of this survey, perceived risk is both an outcome (do employees perceive this airline as safe?) and a criterion (do employees’ perceptions of safety culture predict their overall perception of risk?). As an outcome, employees’ perceptions of organizational risk are largely neutral and their perceptions of personal risk negligible. The average score on the organizational risk items was 3.87, just short of the 4.0 neutral point. While this indicates a reasonably low degree of perceived organizational risk (lower scores here indicate a safer environment), comments by respondents suggest that many were reluctant to make forecasts about what they viewed as a complex and unpredictable phenomenon, often choosing 4.0 to abstain from making a prediction. Overall, however, responses were approximately normally distributed across the entire response range from 1.0 to 7.0, indicating considerable diverse opinions about the likelihood of an accident or incident at the airline in general.

By contrast, there was little diversity of opinion among respondents with respect to perceived individual risk. With an average score of 1.65, 58% of the respondents indicated that they “strongly disagree” that they personally are likely to be involved in either an accident or incident. No respondent endorsed either of these items positively; the maximum score was the neutral point 4.0. Therefore, this measure was dropped from additional analysis.

Perceived risk in the criterion sense refers to the degree with which we can predict a respondent’s perceptions of risk from the five safety culture dimensions. Knowing which dimensions are most strongly related to perceived risk suggests an area of focus to improve risk perceptions and indicate the relative importance of each dimension to the overall safety culture. At the airline, the perceived organizational risk scale (Table 4) was significantly negatively correlated with all five of the dimension scales, indicating that higher dimension scores are related to lower perceived risk.

Table 4. Organizational Risk Correlations to the 5 Dimensions of Safety Culture

Perceived Organizational Risk & OC: -.57
Perceived Organizational Risk & MI: -.57
Perceived Organizational Risk & REW: -.56
Perceived Organizational Risk & EE: -.49
Perceived Organizational Risk & REP: -.40

All correlations are significantly different from zero ($p < .01$).

A regression equation containing all five dimension scales as predictors was able to account for 41% of the variance in organizational risk scores ($R = .639$, $R^2 = .409$, $p = .001$). However, further analysis revealed high correlations between the predictor variables, implying that not all five dimensions were providing unique information. A regression equation including OC alone accounted for 32% of the variance ($R = .569$, $R^2 = .324$, $p < .001$), and adding REW as a predictor accounted for an additional 6.3%, for a total of 39% ($R = .622$, $R^2 = .387$, $p = .049$). This is nearly as good as the model involving all dimensions and includes no redundant information. However, as mentioned previously, these scales were all highly correlated.

While one purpose of the survey was to provide the airline with information regarding the nature and quality of their safety culture, our main purpose for this study was to develop a general measurement instrument that could be used to assess safety culture in a variety of airlines. While many of the items in the survey were derived from previous measures of safety culture, they had not been tested in conjunction with one another or according to the five-dimension theory of safety culture. The survey data and respondent comments from the airline were used to refine and modify the scales for future use.

Refining the Survey

The present study provides empirical support for the Commercial Aviation Safety Survey as an index of airline safety culture. Although further work is needed to refine the measure and establish its validity in a more general population, this initial test answers several necessary questions about the survey items and lays solid groundwork for future development.

On the most basic level, the survey at the airline indicated that responding pilots understood the items and considered them relevant. No item was omitted or designated “not applicable” by more than three pilots, though respondents were expressly instructed to identify items that did not apply to their current

position. Some comments suggested potential problems with the wording of individual items, which can be incorporated into future versions, but these comments were minimal. In all, it does not appear that the pilots who responded had difficulty completing the survey. Several pilots did comment on the Perceived Risk items, indicating that they were uncomfortable making forecasts about a phenomenon they perceived as complex and difficult to predict. This concern suggests that future measures of risk perception may benefit from a different structure or approach. Assessing *relative* risk may be a solution, as it acknowledges a baseline element of risk and does not require the respondent to make an absolute judgment.

All five scales were found to demonstrate appropriate reliability. The content of items in each abbreviated scale (i.e., the most intercorrelated items) appears to reflect the conceptual definition of the corresponding dimension, but it was not possible to conduct formal tests of the structure of the data (factor analysis) due to the low sample size. High correlations between scales suggest that fewer than five dimensions may actually exist in the data, though again this could not be tested without factor analysis. Organizational Commitment and Management Involvement appeared to be a single dimension in this sample, but it is difficult to determine whether this represents a truly unitary construct, an inability of the items to discriminate between the two, or simply a reflection of the airline’s size and organizational structure. Further testing with a larger sample in a larger organization is necessary to fully address this.

This survey did suggest a change in focus for one dimension. We changed the Reward dimension, originally conceptualized to focus on the consequences and contingencies surrounding safe and unsafe behavior, to “Accountability.” Several respondents made comments suggesting that the focus on reward may have been inappropriate, or that a slightly different approach to the topic would be more informative. They indicated that concerns about safety culture were not due to a lack of consequences for unsafe behavior, but a lack of consistency with which the consequences were applied. Respondents mentioned situations in which unsafe acts were viewed differently depending on the situation (i.e., cost-saving or not) or the pilot involved. Items involving positive consequences for safe behavior generally performed poorly. Many comments suggested that safe behavior is an integral component of a pilot’s job, not above-and-beyond behavior that should be specially rewarded. It seems more appropriate, then, to look at this contingency system

in terms of accountability and consistency rather than reward and recognition. The scale has been renamed and refined in these terms.

Discussion

The objectives of the present study were twofold: (1) to assess the current state of safety culture among pilots at the airline, and (2) to provide an initial practical and empirical test of the items in the Commercial Aviation Safety Survey. Both objectives were largely accomplished, though certain limitations of the research do exist. In all, the data suggest valuable insights into both the safety culture of one organization and the problem of assessing safety culture in general.

Though the present research is only one step in the development of a measure of airline safety culture, it provides considerable insight into what future steps might entail. The most pressing need is for replication in a sample large enough to permit factor analysis, so that the five-dimensional structure of the items can be validated or corrected. The airline example suggests that the nature of the dimensions may vary according to the size and structure of the organization; that is, larger organizations may require more or different dimensions than small ones. Testing across a wider sample of airlines is also necessary to establish predictive validity: whether differences in safety culture scores predict differences in risk perceptions or actual accident/incident rates.

The present survey is targeted exclusively toward pilots, but pilots are not the only airline employees responsible for safety in aviation. A corresponding survey for maintenance personnel is currently under development. The ultimate goal of the project is to develop an instrument or set of instruments that can be made available to a variety of airlines (or to the Federal Aviation Administration) in order to assess the strengths and weaknesses of a particular safety culture.

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