Using an Eight-Factor Model to Measure Error Attitudes at a Regional Airline

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Abstract

One of the key features of a healthy safety culture is a non-punitive error reporting system. However, employees may not be willing to report for reasons such as fear of reprisal, embarrassment, or pernicious attitudes. This study investigated error attitudes of employees at a regional airline. The Error Orientation Questionnaire was used to collect data on eight factors which included; (a) error competence, (b) learning from errors, (c) error risk taking, (d) error strain, (e) error anticipation, (f) covering up errors, (g) error communication, and (h) thinking about errors. An additional qualitative component consisted of participants' perceptions of why they personally committed an error on the job as well as why they believed someone they knew committed an error. A key finding of this study, from employees' point of view, is that pressure, situation awareness, and complacency are primary factors in error causation. Implications and countermeasures are discussed.

Human error on the job has traditionally been addressed by some kind of punitive action toward the culpable offender. Error reduction strategies ranged from "blame and train" to a few days off without pay and even termination of the employee. While this did nothing to prevent the same types of errors from occurring again, it seemed at face to be the simplest and most cost-effective solution to the problem. This type of organizational approach to human error seemed logical on a superficial level; terminate the culpable violator and the problem will be solved. On a deeper level, however, it fell well short of identifying the antecedent and root causes of errors. Rather than a misguided management issue, the problem appeared to be a cultural perturbation and thus fairly resistant to change.

Today there appears to be a paradigmatic shift in organizations' handling of errors. With the understanding that human error is both universal and inevitable (Reason & Hobbs, 2003), organizations are beginning to accept the fact that errors can and will happen and that more productive mitigation strategies are required. These mitigation strategies must begin with a Just Culture (Reason, 1997). A Just Culture is a culture that acknowledges that well-intentioned people still make mistakes and should not be punished for slips, lapses, mistakes, and other common everyday errors. Yet, a line is still drawn where it is understood that willful violations and purposeful unsafe acts must be dealt with in some sort of punitive fashion. The general indications are that only around 10 percent of actions contributing to bad events are judged as culpable (Reason, 2004, as cited in Global Aviation Information Network, 2004, p. vi). The bottom line of a Just Culture is *trust.* Employees must know that they can report errors without sanction. Once this trust is established then an organization can have a reporting culture, something that provides the system with an accessible memory, which, in turn, is the essential underpinning to a learning culture (p. vi). Along the same lines, Eiff (1999) suggests that, "An

effective and systematic reporting system is the keystone to identifying the weakness and vulnerability of safety management before an accident occurs." Thus a key aspect of a reporting system is that it works proactively to prevent accidents whereas earlier approaches focused almost entirely on reactive methods (or studying accidents after they occurred). However, for a truly holistic approach to accident prevention, a combination of both of these approaches is required.

Attitudes relating to errors can, in and among themselves, be a line of defense in error-provoking situations and environments. In fact, in one of the more well known error models known as the Human Factors Analysis and Classification System (HFACS), *attitudes* are explicitly referenced. The taxonomy states that, "Adverse mental states of operators may be due to personality traits and pernicious attitudes such as overconfidence, complacency, and misplaced motivation" (Shappell & Wiegmann, 2000, p. 7). These types of attitudes can clearly influence, and in fact exacerbate, error-provoking behavior. However, there are numerous other error-related attitudinal constructs that, to date, have been grossly ignored. These would include employee attitudes towards errors themselves.

Instrument

There are relatively few instruments that have been specifically designed to measure error attitudes with demonstrated sound psychometric properties. However, an extensive search revealed that the Error Orientation Questionnaire (EOQ: Rybowiak, Garst, Frese, & Batinic, 1999) would fit this requirement and was used for this study. Although the EOQ labels *orientation* as the study variable, for the purpose of this study, orientation will be used

interchangeably with *attitude.* Attitude will be defined as *the way an individual feels about something or someone, which in turn affects an individual's responses and actions.*

The EOQ is a 37 item non industry-specific survey questionnaire with demonstrated validity and reliability. The EOQ uses eight scales to measure attitudes toward, and coping with, errors at work. The eight factor model was derived through a self-replicated study. Six scales (error competence, learning from errors, error risk taking, error strain, error anticipation, and covering up errors) were developed in the first study through confirmatory factor analysis using LISREL techniques. The two additional scales (error communication and thinking about errors) were derived from the second study. Definitions of each scale are provided below.

Error Competence

Error competence is defined as, "Active knowledge for immediate recovery from errors and reduction in error consequences. It relates to self-efficacy, to action-orientation after failure, need for achievement and quite highly to initiative" (Rybowiak et al., 1999, p. 542).

Learning From Errors

Learning from errors is defined as, "The ability to prevent errors in the long term by learning from them, planning, and changing work processes. There are correlations with self-efficacy, qualification, plan-orientation, need for achievement, readiness to change, and initiative" (Rybowiak et al., 1999, p. 543).

Error Risk Taking

Error risk taking is defined as, "The result of an achievement-oriented attitude which requires flexibility and taking responsibility. There are positive relations to need for achievement, qualification, readiness for change and initiative, as well as a negative relation to control rejection" (Rybowiak et al., 1999, p. 543).

Error Strain

Error strain is defined as, "A generalized fear of committing errors and by negative emotional reactions. It correlated negatively with self-efficacy, self-esteem, and initiative and positively with control rejection, psychosomatic complaints, depression, and negative affectivity" (Rybowiak et al., 1999, p. 543).

Error Anticipation

Error anticipation is defined as, "A general expectancy that errors will happen, because one has a realistic view that even in one's field of expertise errors will occur. It correlated positively with negative affectivity and error strain, and negatively with optimism" (Rybowiak et al., 1999, p. 534).

Covering up Errors

Covering up errors is mainly the strategy of a non-self-assured person and may also be an adaptation to error-sensitive conditions at work, for example, job uncertainty. It relates to low self-esteem, negative affectivity, high control rejection, and little initiative, but also to career stress and job uncertainty (Rybowiak et al.,1999, p. 543).

Error Communication

A definition of *error communication* was not provided in the Rybowiak et al. study. For the purpose of this study, error communication is defined as the ability to communicate one's errors to the proper channel or to rely on coworkers to rectify any errors that may occur.

Thinking About Errors

A definition of *thinking about errors* was not provided in the Rybowiak et al. study. For the purpose of this study, thinking about errors is defined as the reactive thought process that occurs when one commits an error in order to prevent the error from happening again.

Method

Distribution of the EOQ was coordinated and conducted through the airline's management and participation was voluntary. The EOQ was distributed via email to approximately 400 employees who were advised that the questionnaire needed to be filled out and returned within 30 days after receipt. A reminder was sent to employees after a two week period. The employees were asked to complete and anonymously mail or fax their EOQs to a point of contact at the airline. The point of contact was instructed to collect and forward all the questionnaires to the researcher at the conclusion of the collection period.

Results

A total of 65 EOQs were returned for a response rate of 16% (n=65). Although not an impressive response rate, for descriptive purposes, this sample is adequate. The sample population consisted of 47 males (72%) and 18 females (28%). Age ranged from a categorical low of 18-22 years with a categorical high of 63+ years with the most pronounced age category between 18-22 (22%). Total years of experience in the aviation business ranged from a categorical low of 1-5 years with a categorical high of 31+ years with the most pronounced experience range between 1-5 years (42%). Reported employment departments included Ramp Operations (40%), Flightcrew (25%), Other (25%), Flight Operations (5%), Maintenance (3%), Dispatch (1%), Safety (1%). Forty seven (72%) indicated they were in Non-Management positions while 18 (28%) indicated they were in a Management position. The majority of participants (97%) indicated they worked in a Safety Sensitive position.

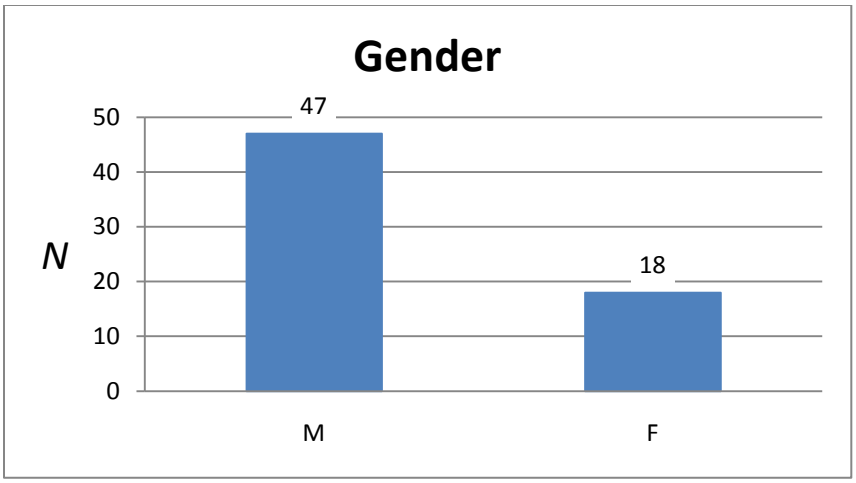

Figure 1. Sample Population by Gender.

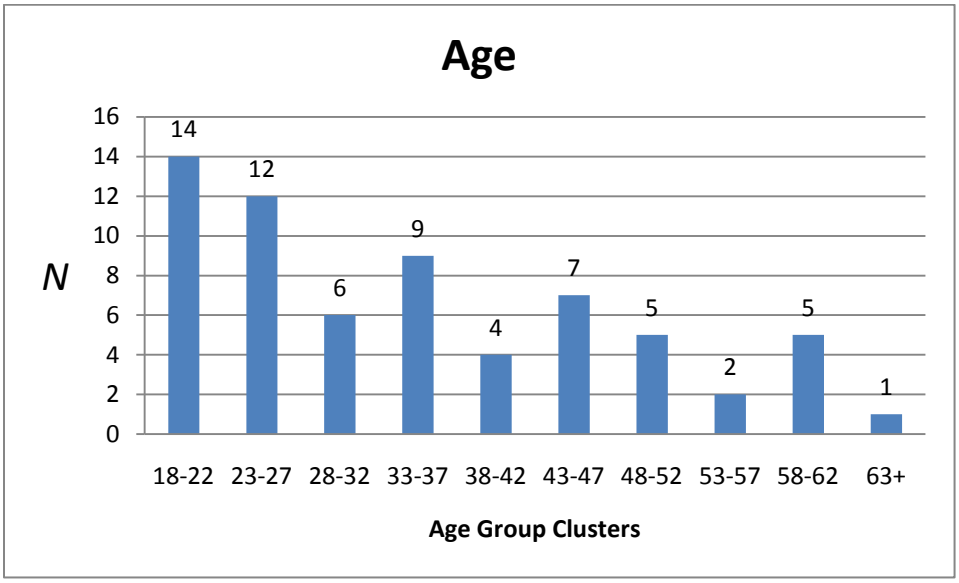

Figure 2. Sample Population by Age.

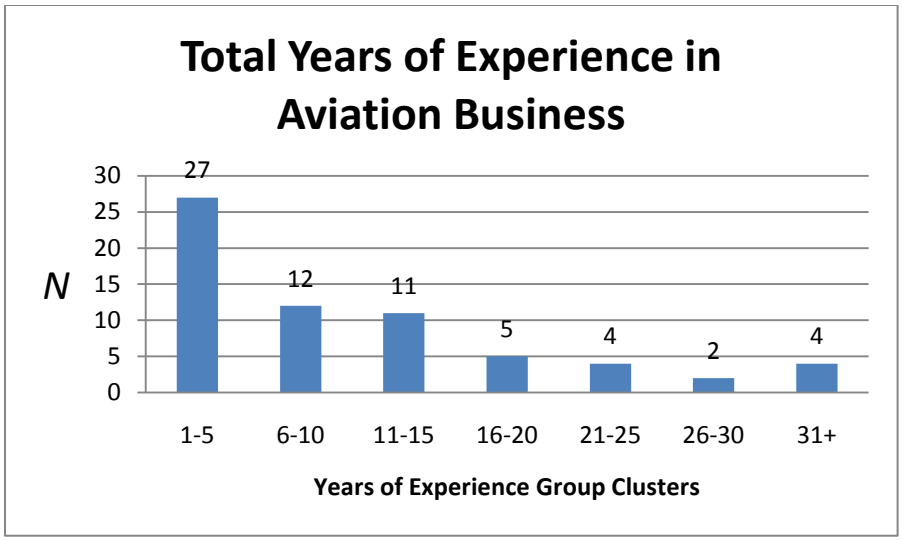

Figure 3. Sample Population by Total Years of Experience in Aviation Business.

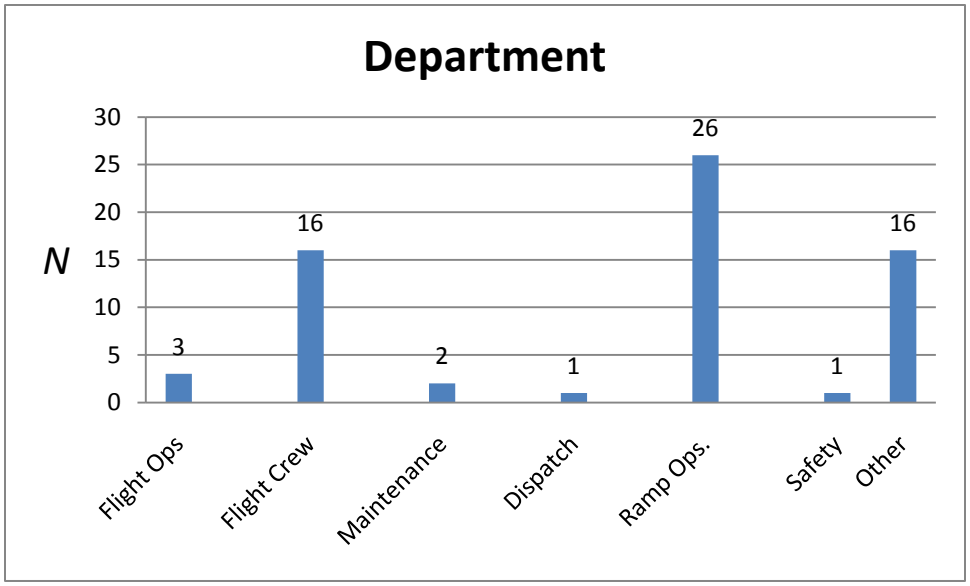

Figure 4. Sample Population by Department.

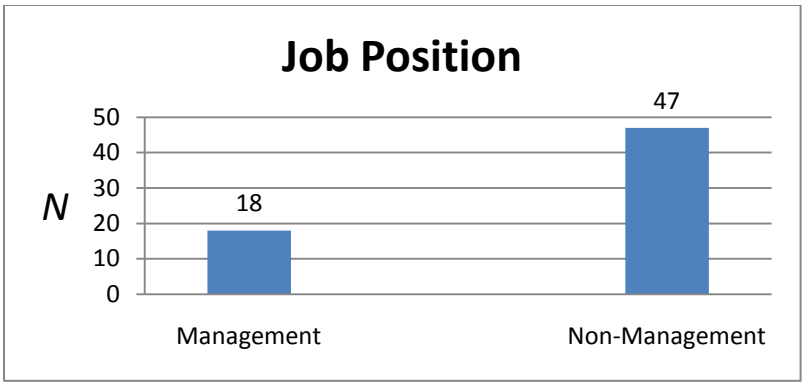

Figure 5. Sample Population by Job Position.

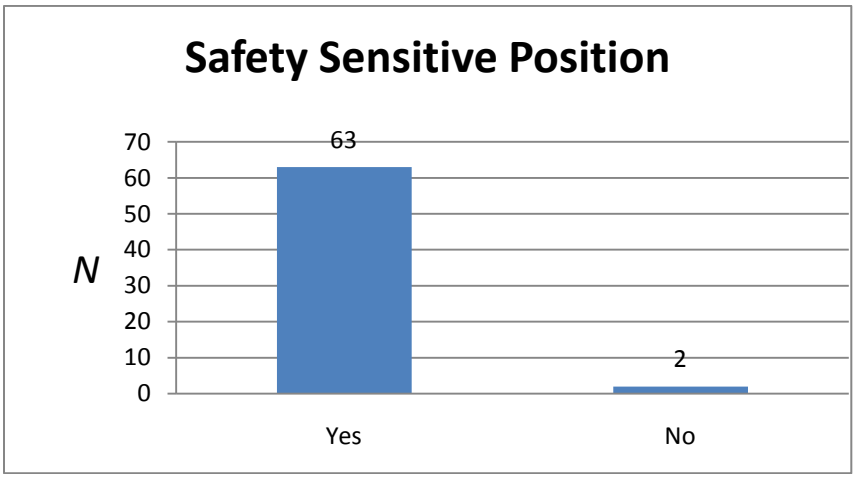

Figure 6. Sample Population by Safety Sensitive Position.

Descriptive data were used to present the EOQ results. The mean scores (and standard deviations) were divided between non-management and management positions with the initial intent to check for significant differences between these groups. However, due to the relatively small sample size (n=65) inferential statistics were not used. An a priori power analysis revealed that the sample size would be too small to make any valid inferences to the population at large. The eight scales were segregated by theme and are presented below.

Table 1. Error Competence Scale

Item No.	Description	Non-Mgmt (N=47)		Mgmt (N=18)	
		M	SD	M	SD
8	When I have made a mistake, I know immediately how to rectify it.	3.46	(0.776)	3.55	(0.704)
15	When I do something wrong at work, I correct it immediately.	4.36	(0.605)	4.16	(0.707)
16	I f it is at all possible to correct a mistake, then I usually know how to go about it.	3.80	(0.741)	4.11	(0.832)
19	I don't let go of the goal, although I may make mistakes.	4.00	(1.000)	3.38	(0.916)

1: Not at all, 2: A bit, 3: Neither a bit nor a lot, 4: A lot, 5: Completely

Table 2. Learning from Errors Scale

Item No.	Description	Non-Mgmt (N=47)		Mgmt (N=18)	
		M	SD	M	SD
4	Mistakes assist me to improve my work.	3.97	(1.073)	4.00	(0.970)
14	Mistakes provide useful information for me to carry out my work.	3.25	(1.259)	3.50	(0.857)
17	My mistakes help me to improve my work.	3.87	(0.991)	4.05	(0.872)
29	My mistakes have helped me to improve my work.	3.72	(1.036)	4.05	(0.937)

1: Not at all, 2: A bit, 3: Neither a bit nor a lot, 4: A lot, 5: Completely

Table 3. Error Risk Taking Scale

Item No.	Description	Non-Mgmt (N=47)		Mgmt (N=18)	
		M	SD	M	SD
13	If one wants to achieve at work, one has to risk making mistakes.	2.74	(1.241)	3.33	(0.840)
26	It is better to take the risk of making mistakes than to “sit on one’s behind”.	3.27	(1.346)	2.88	(1.022)
27	To get on with my work, I gladly put up with things that can go wrong.	3.02	(1.343)	2.66	(0.970)
31	I’d prefer to err, than to do nothing at all.	2.80	(1.469)	2.72	(1.178)

1: Not at all, 2: A bit, 3: Neither a bit nor a lot, 4: A lot, 5: Completely

Table 4. Error Strain Scale

Item No.	Description	Non-Mgmt (N=47)		Mgmt (N=18)	
		M	SD	M	SD
6	I find it stressful when I err.	3.55	(1.119)	3.88	(0.963)
25	I am often afraid of making mistakes.	2.61	(1.207)	3.11	(1.131)
32	I feel embarrassed when I make an error.	3.10	(1.303)	2.94	(0.998)
36	If I make a mistake at work, I “lose my cool” and become angry.	1.39	(0.613)	1.33	(0.766)
37	While working I am concerned that I could do something wrong.	2.93	(1.143)	2.33	(1.028)

1: Not at all, 2: A bit, 3: Neither a bit nor a lot, 4: A lot, 5: Completely

Table 5. Error Anticipation Scale

Item No.	Description	Non-Mgmt (N=47)		Mgmt (N=18)	
		M	SD	M	SD
20	In carrying out my task, the likelihood of errors is high.	2.14	(0.955)	2.61	(1.195)
24.	Whenever I start some piece of work, I am aware that mistakes occur.	3.02	(1.259)	3.11	(1.231)
28.	Most of the time I am not astonished about my mistakes because I expected them.	2.04	(1.284)	2.50	(0.923)
30	I anticipate mistakes happening in my work.	2.74	(1.169)	2.94	(1.055)
35	I expect that something will go wrong from time to time.	3.13	(1.258)	3.16	(1.294)

1: Not at all, 2: A bit, 3: Neither a bit nor a lot, 4: A lot, 5: Completely

Table 6. Covering up Errors Scale

Item No.	Description	Non-Mgmt (N=47)		Mgmt (N=18)	
		M	SD	M	SD
11	Why mention a mistake when it isn't obvious?	2.19	(1.244)	2.50	(1.098)
21	It is disadvantageous to make one's mistakes public.	2.19	(1.191)	2.22	(0.942)
22	I do not find it useful to discuss my mistakes.	1.91	(1.039)	1.83	(0.923)
23	It can be useful to cover up mistakes.	1.57	(0.800)	1.66	(0.907)
33	I rather keep my mistakes to myself.	2.02	(1.021)	2.00	(0.970)
34	Employees who admit to their errors, make a big mistake.	1.41	(0.717)	1.33	(0.766)

1: Not at all, 2: A bit, 3: Neither a bit nor a lot, 4: A lot, 5: Completely

Table 7. Error Communication Scale

Item No.	Description	Non-Mgmt (N=47)		Mgmt (N=18)	
		M	SD	M	SD
1	When I make a mistake at work, I tell others about it in order that they do not make the same mistake.	3.85	(1.042)	3.77	(1.003)
3	If I cannot rectify an error by myself, I turn to my colleagues.	4.25	(0.896)	4.11	(0.900)
9	If I cannot manage to correct a mistake, I can rely on others.	3.85	(1.250)	4.11	(0.758)
12	When I have done something wrong, I ask others, how I should do it better.	3.53	(1.060)	3.33	(1.084)

1: Not at all, 2: A bit, 3: Neither a bit nor a lot, 4: A lot, 5: Completely

Table 8. Thinking About Errors Scale

Item No.	Description	Non-Mgmt (N=47)		Mgmt (N=18)	
		M	SD	M	SD
2	After I have made a mistake, I think about how it came about.	4.23	(0.889)	4.05	(0.872)
5	I often think: “How could I have prevented this?”	4.12	(0.849)	4.22	(0.942)
7	If something goes wrong at work, I think it over carefully.	4.12	(0.849)	4.00	(1.084)
10	After a mistake has happened, I think long and hard about how to correct it.	3.91	(1.017)	4.27	(0.669)
18	When a mistake occurs, I analyze it thoroughly.	4.02	(0.966)	4.22	(0.646)

1: Not at all, 2: A bit, 3: Neither a bit nor a lot, 4: A lot, 5: Completely

A qualitative component was also included in this study. The qualitative data consisted of participants' perceptions of why they personally committed an error on the job as well as why they believed someone they knew committed an error. These questions were added to the EOQ and were numbered as questions 38 and 39. Some respondent reports had to be discarded due to irrelevance. For instance, responses such as "I was late for work because I overslept" or "normal workplace hazards" did not provide any meaningful data for this study.

The errors were categorized based on their subjective root causes. Some errors were difficult to assign to a specific category due to insufficient information or duplicity tendency. In this case the category with the closest primary fit, based on the available information, was used. Twelve error categories emerged (with percentages by response rate) which consisted of:

1. Pressure (22%)
2. Situation Awareness (20%)
3. Complacency (15%)
4. Knowledge (8%)
5. Procedural Deviations (7%)
6. Training (6%)
7. Fatigue (5%)
8. Lapse (4%)
9. Communication (4%)
10. Experience (3%)
11. Equipment (2%)
12. Distraction (2%)

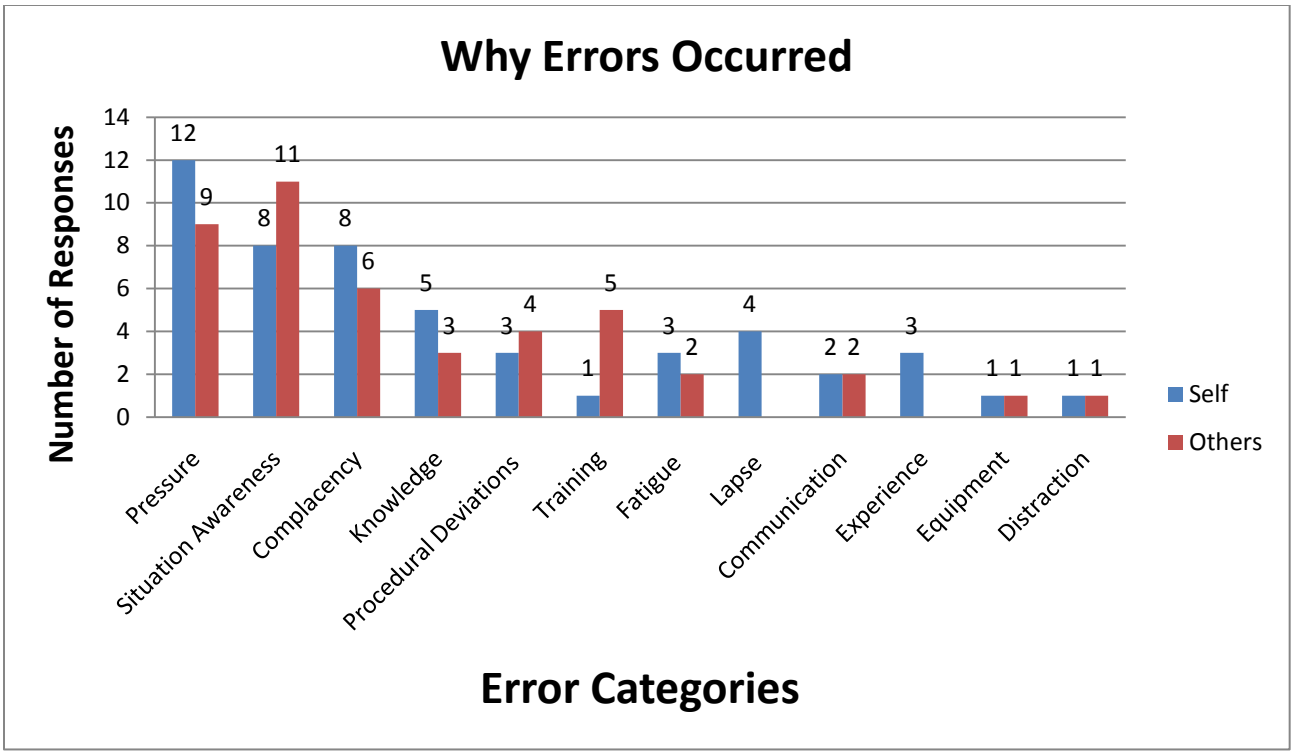

Figure 7. Why Errors Occurred (self and others).

Table 9. Qualitative Responses to Error Causation by Self and Others

38. Think about an error (minor or major) *you* made on the job. In one sentence only please describe what you think the reason was for the error.	39. Think about an error (minor or major) that *someone you know* made on the job. In one sentence only please describe what you think the reason was for the error.
Pressure 1. Rushing to make on time departure 2. I failed to latch the door properly 3. I was trying to move too fast 4. Rushing to complete objective/Time constraints 5. Fueling too fast 6. Rushing a task and not being alert 7. Stress, busy, fast-paced work environment 8. I was rushing to complete a task 9. Time pressure 10. Time pressure 11. Pressure to hurry resulting in forgetting something 12. Deciding too quickly without discussing with others	Pressure 1. They had so many things happening at once 2. Going out on the ramp without a safety vest on, just being in a rush to get to the plane 3. Rushing and not think each step through to the end 4. The person was rushing on the ramp while driving a vehicle 5. Trying to do things too quickly 6. Rushing 7. Trying to do it all by himself 8. Too much on their plate at once 9. Rushing
Fatigue 1. I was tired 2. Pilot fatigue 3. Fatigue	Fatigue 1. Long work hours, busy day 2. Pilot fatigue
Lapse 1. Let an important date lapse/Relied too much on others to watch for it 2. Could not remember the steps involved to complete the procedure 3. Forgetting to file paperwork because I got too busy 4. I had a momentary lapse of judgment	Lapse _
Experience 1. My inexperience 2. New to position 3. New at the job	Experience _

Training 1. Lack of complete training	Training 1. They were not trained properly 2. Lack of complete training 3. Not being trained effectively 4. Lack of training 5. Lack of training
Knowledge 1. Not enough knowledge 2. Lack of understanding in a given field 3. I did not have a complete understanding of the situation 4. It was a new piece of equipment that I was unfamiliar with 5. Lack of information	Knowledge 1. Lack of job knowledge 2. Not enough knowledge 3. They did not understand all factors involved
Situation Awareness 1. Not paying attention 2. Not paying attention 3. Lack of attention 4. Not preparing in advance for the task 5. Awareness of one's surroundings, overlooking minor details 6. We often send bags inadvertently to the wrong destinations. This is a product of not double checking bag tags 7. Lack of attention 8. Leaving something unlocked by not paying proper attention	Situation Awareness 1. Lacking attention to detail 2. Not putting the truck in park 3. Lack of attention 4. Fixation on a goal at the expense of good situational awareness 5. An ex coworker was working on the ramp. He was busy and didn't realize he left the truck in reverse and it accidentally hit the nose of the plane. I guess he wasn't thinking or he was focused on something else at the time. He should have double checked before getting out 6. Carelessness was the reason for the error 7. The person just wasn't paying attention to what they were doing 8. Hit an aircraft because they were not paying attention 9. He failed to consider his dangerous situation and react to it because the "manual" didn't provide a specific remedy to the situation. Inability to use common sense in the situation 10. Not paying attention 11. Not knowing their surrounding and lack of information

Communication 1. I think the reason for my error was a simple miscommunication as to the destination of an aircraft 2. I couldn't understand the customer	Communication 1. Not listening to others 2. Lack of communication
Complacency 1. Complacency 2. Becoming too comfortable with my duties and not thinking hard enough about what I'm doing 3. Incorrect presumptions being the foundation for an analysis 4. I got too used to doing the action every day 5. I was complacent 6. Incorrect assumptions upon starting the task 7. Assumed something was true when it wasn't 8. Didn't revise something I do every time	Complacency 1. Complacency 2. Almost landing with the gear up/Complacency 3. Too comfortable with position 4. Becoming too comfortable in the way the task is completed and not referencing current documents 5. He was complacent 6. Assumed weight was in pounds when it was in kilos
Procedural Deviations 1. Not following checklists or procedures 2. The inability to utilize correct procedures and checklists even though they were available 3. Not double checking the procedure	Procedural Deviations 1. Failure to follow the approved and trained procedures 2. The baggage cart was taken by the wind because someone didn’t chock it 3. Not following checklists or procedures and complacency 4. Carelessness and laziness causing SOP to not be followed. Compounded by poor QA and Oversight
Equipment 1. Accidentally lost all radio, avionics as wearing gloves (no heater) caused me to switch them off momentarily by mistake, as heater was not maintained sufficiently	Equipment 1. Ramp staff did not secure the main cabin doors properly as they were not adjusted/difficult to operate and should have been fixed sooner by the company
Distraction 1. I was distracted by a nonstandard (abnormal) event	Distraction 1. Left open a secured gate

Discussion

This study yielded some very useful data. From the demographics standpoint, it was interesting to note what segment of the study population decided voluntarily to participate in this research. The majority of respondents were male, relatively young, and have worked in the aviation business for a relatively short amount of time. The largest respondent group, by department, was ramp operations. Most respondents indicated they were in non-management positions and almost all indicated that they worked in a safety-sensitive position.

Descriptive statistics were used to present the EOQ results which were categorized in eight scales. Within the scales the results were segregated between participants in non-management positions (n=47) and those in management positions (n=18). For each group, the means and standard deviations were presented. Although inferential statistics were not used, the data are presented in such a way as to enable the reader to acquire a "visual comparison with numbers."

Overall, within the eight scales, there were some notable areas for discussion. First, the mean scores overall did not show any *major* variation between the non-management and management groups. However, some content items had a noticeable difference between the means or standard deviations. For instance, in the Error Competence Scale (see Table 1), Item No. 19, *I don't let go of the goal, although I may make mistakes,* showed a moderate difference in means between non-management (M=4.00) and management (M=3.38). This indicates that those employees in non-management compared to management positions have a stronger orientation towards completing a goal knowing that mistakes may happen. In the Error Risk Taking Scale (see Table 3), Item No. 13, *If one wants to achieve at work, one has to risk making mistakes,* showed a moderate difference in means between non-management (M=2.74) and

management (M=3.33). This indicates that those employees in management compared to non-management positions have a stronger orientation towards work achievement at the risk of making mistakes. Also, the standard deviation was larger for the non-management group (SD=1.241) but there was less variation in the management group (SD=0.840). In fact, within the entire Error Risk Taking Scale, all content items scored considerably larger standard deviations in the non-management group compared to the management group. However, caution is urged in making any inferences regarding variability as there was a considerable difference in the group sizes.

The qualitative portion of the study uncovered additional information that was useful in supporting the results of the EOQ. The qualitative data consisted of participants' perceptions of why they personally committed an error on the job as well as why they believed someone they knew committed an error. Twelve error categories emerged (with percentages by response rate) which consisted of:

1 Pressure (22%)
2 Situation Awareness (20%)
3 Complacency (15%)
4 Knowledge (8%)
5 Procedural Deviations (7%)
6 Training (6%)
7 Fatigue (5%)
8 Lapse (4%)
9 Communication (4%)
10 Experience (3%)
11 Equipment (2%)
12 Distraction (2%)

It is interesting to note that the top three categories combined (pressure, situation awareness, and complacency) accounted for well over 50% of perceived error causes. These will now be discussed separately.

Pressure is derived from the daily demands of tight flight schedules and affects all personnel including pilots, mechanics, dispatchers, and in fact anyone directly or indirectly involved with the completion of a flight. Among other things, pressure can lead to shortcutting procedures, irrational decision making, and loss of focus. While pressure is not something that can be readily eliminated in the aviation environment, it can be mitigated to a certain extent. Countermeasures include an awareness of the effects of pressure as well as the ability to understand when and where a line needs to be drawn between "everyday pressure" and the type of pressure that can lead to consequential errors. Being assertive and speaking up can help. Consider using a metacognitive approach when under extreme pressure. Metacognition is an awareness of your own thoughts and decisions. Think in terms of "I am under extreme pressure and because of this I am going to_____in order to get the job done." The blank line may indicate a deviation from a normal or approved procedure and may very well become a link in an accident chain.

Situation awareness (SA) is knowing where you have been in the past, where you are currently, and where you are projected to be in the future. Mostly related to cockpit operations, SA can also be applied to maintenance and other activities. A common word, *attention*, was used in many of the SA qualitative reports. Arguably, attention (or lack of) could be categorized on its own but for simplicity was integrated into the SA category. There is no shortage of examples where a loss of situation awareness has caused a perfectly airworthy aircraft to collide with water, terrain, or mountains. Two prominent examples are an American Airlines B757 that crashed near Cali Colombia in 1995 and an Eastern Airlines L-1011 that crashed in the Florida Everglades in 1972. The prior involved misprogramming the flight computer without verifying and crosschecking the input compounded by a complacent flightcrew. The latter involved all

flightcrewmembers troubleshooting a nose gear indicator light at the expense of monitoring the aircraft's altitude. The autopilot, which had been engaged, became disconnected and the aircraft slowly descended into the Everglades without any awareness by the crew. In both of these examples there was an egregious loss of SA (or in simple terms knowing what the aircraft was doing at a particular moment in time) leading to a fatal accident. Countermeasures for SA include creating an awareness of the reasons why SA may be compromised at a given time. For instance, high workload situations, ineffective workload management, lack of delegation, and complacency may all lead to a loss of SA. In flight operations it is critically important that one pilot monitors the other pilot, or in cases where the autoflight system is engaged, monitors the autopilot. The advent of the Enhanced Ground Proximity Warning System (EGPWS) has helped pilots to maintain better SA, or in some cases, has served as a last line of defense in situations that otherwise may have ended in a Controlled Flight Into Terrain (CFIT) accident. While technology such as EGPWS and GPS are useful to increase SA, it should be understood that these are tools that are used to augment SA rather than the primary sources for maintaining SA. When pilots become overly dependent on technology and an element of complacency sets in then there is an increased likelihood that SA may become compromised during various phases of flight. That was exactly what happened to the aforementioned American Airlines B757 that crashed into a mountain near Cali Colombia. Maintaining good SA is required for the entire duration of a flight but it is critically important during the approach phase, especially in areas of mountainous terrain.

Complacency is a feeling of contentment and self-satisfaction and is problematic due to its tendency to put employees in an "autopilot mode." A person may feel that because they have done the job a hundred times previously with no problems then there will be no problems this

time. Tasks may become repetitive and mundane with less conscious attention and awareness by the employee. This has become a major issue in maintenance-related accidents where complacency has been cited as a contributing factor in airframe or powerplant inspections. In 1988 an Aloha Airlines B737 experienced a rapid decompression when an 18 foot section of fuselage separated from the aircraft at 24,000 feet. The cause of the accident was fatigue damage which should have been detected during a routine inspection. However, due to physical access problems in the inspection area compounded by complacency, the damage was not detected. According to the National Transportation Safety Board (NTSB):

> The task of examining the area around one rivet after another for signs of minute cracks while standing on scaffolding or on top of the fuselage is very tedious. After examining more and more rivets and finding no cracks, it is natural to begin to expect that cracks will not be found. (NTSB, 1989)

In 1996 a Delta MD-88 experienced an uncontained engine failure during the initial part of its takeoff roll at Pensacola Regional Airport in Florida. The uncontained engine failure was the result of a "fracture of the left engine's front compressor fan hub, which resulted from the failure of Delta Air Lines' fluorescent penetrant inspection (FPI) process to detect a detectable fatigue crack" (NTSB, 1998). Although this systemic issue was a major contributing factor, on an individual level there was evidence to suggest that the inspector could have detected the fracture as a last line of defense and thus prevented the accident from occurring. According to the NTSB:

> FPI inspectors are required to diagnose each detected indication to determine if it is a crack because a crack is reason to reject the part. But not every indication is a crack, and most preliminary indications are later found not to be cracks. The inspector who

> inspected the accident hub stated that he could not recall ever having detected a crack on a -219 hub, and the inspector's supervisor stated that he was not aware that cracks had ever been found on a -219 hub at Delta. Therefore, the inspector's experience diagnosing indications on -219 hubs consisted of a series of false indications. Although the inspector stated that he approached a part as if it had a crack to detect, his experience with indications on -219 hubs most likely biased his expectation of confirming that an indication was a crack, especially if the indication was not clearly defined. (NTSB, 1998)

There are parallels to the aforementioned Aloha accident in that an experienced inspector missed theoretically detectable damage due to, among other things, low expectation and hindsight bias. Complacency can be considered a manifestation of these factors. Countermeasures for complacency include the following:

1. Increasing awareness of complacency's potential consequences.
2. Understand that just because a task or inspection has been completed successfully a hundred times before, it does not guarantee that the outcome will be successful this time.
3. Don't let down your guard.
4. Assume that something may have been missed.
5. Always double check your own work, especially if an additional set of eyes is not required for a particular task (such as completing a task and signing it off yourself).

Limitations

There were a number of limitations that may have affected this study. First, the sample population that responded to the EOQ survey may not have been representative of the population at large. The relatively low response rate (16%) may not have adequately measured the attitudes across various levels of the organization. For instance, the highest response rate came from those employees who worked in ramp operations with a much lower response rate from those employees in maintenance. This may have created a disproportionate amount of responses from one group at the expense of another. Second, this was a descriptive study with a non-random sampling methodology. Thus, hypotheses were not posited and inferential statics were not used. All results should be interpreted carefully and not assume any results reflected statistical significance. Third, although the EOQ is a valid instrument there were a few issues raised by respondents regarding the wording of statements and thus the quality of the responses. This may have been due to the EOQ originally being developed in German and then translated into English.

Conclusion

Valuable insights were gained as they pertained to error attitudes at a regional airline. The mixed method approach served well in terms of quantifying error attitudes with an additional qualitative component that explored workers' perceptions of why errors occurred; both within themselves as well as in others. The top three causes were pressure, situation awareness, and complacency, and between them accounted for well over 50% of perceived error causes.

It is important to understand the implications of error attitudes in the workplace. Errors should not cause embarrassment or shame. They should be used as a learning tool so that the same types of errors can be prevented from happening again. An error reporting system will be a major component of the soon-to-be mandated safety management systems for aviation operators in the United States. Understanding the psychology of errors is critically important to the successful implementation of an error reporting system. This study showed, at least on a descriptive level, that there are differences between non-management and management in terms of error attitudes. It would be highly desirable to conduct additional research in this area, perhaps by replication of this study. Building a rich database will allow meta-analyses to be conducted. Hypotheses can then be posited and tested for statistical significance. At the very least it is hoped that the results of this study are useful for academics and practitioners alike and that research on error attitudes will continue to be addressed in the future.

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