Risk Perception in Commuter Airline Operations: Objective versus Subjective Perceptions of Risk

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Abstract

This paper compares the subjective and objective estimates of risk among different groups of commuter airline employees. Previous research has suggested that individuals tend to underestimate their own likelihood of accident involvement and display poor awareness of true accident probabilities. In the present study, the subjective estimates of risk by airline employees was contrasted with the risk data provided by worldwide commuter airline accident statistics. There was a strong tendency to rate external factors outside flight crew control, such as the maintenance of essential flight control systems and weather-related factors, such as turbulence and thunderstorms, as more hazardous and more likely to occur than is suggested by the accident data. In contrast, personal factors such as poor flight crew judgement and poor flight crew operation of equipment were rated as much less significant than these accident data would suggest. These results indicate that the primary task for management in minimizing human error may be to recognise and acknowledge subjective estimates of risk and to find participative ways to improve an employee’s sense of control and mastery of workplace hazards. The findings of the study are discussed in relation to research undertaken in the area of attribution and risk communication.
Introduction

According to Haight (1986) there is little agreement on a technical definition of the term risk. For example, Christensen (1987) proposes that risk can be defined as the probability or likelihood of injury or death. In contrast, Oppe (1988) defines risk as the expected loss of an alternative to be chosen.

This lack of agreement may be due, in part, to confusion over similar terms such as hazard, danger and harm. These latter terms may be distinguishable from risk by consequence. In other words, risk is a frequency, or rate that can be estimated, whereas terms such as hazard, danger or harm are the characteristics of objects or events, which could result in adverse consequences (Brown & Groeger, 1988).

Risk is sometimes defined in terms of statistical likelihood or probability (usually referred to as objective risk) and often used as a synonym for danger or threat (subjective risk). This variability may be due to differences in expertise, where experts on risk tend to use the term to express likelihood or probability and lay persons use the term to denote the magnitude of hazard or danger. For example, Wogalter, Desaulniers and Brelsford (1987) found that individual perceptions of the hazardousness of products was related to their perception of the severity of injuries that might result from a product. However, Slovic, Fischhoff and Lichtenstein (1980) have suggested that risk perception of a product is determined by a combination of both severity and likelihood of injury.
According to Young, Brelsford and Wogalter (1990) the reason for variability in research results is that the terms risk and hazard may differ in meaning. For example, the concept of likelihood may be more closely related to perceptions of risk but may not contribute greatly to perceptions of hazard, thereby creating a potential source of confusion. These authors go on to suggest that the failure of experts, in the past, to adequately communicate information about risk to the public, may be partly due to the fact that the public interprets/perceives risk differently to that of experts.

Differences in the definition of risk may also be a reflection of how risk is measured. In objective measures of safety, there is usually an identical use of the term’s risk and accident rate. However, risk is also used as a synonym for danger, which stresses a more subjective attitudinal aspect of risk. Objective risk usually involves the quantification of risk in relation to exposure, such as fatal accident rates per 100,000 flight hours, whereas subjective risk refers to the psychological dimensions associated with perceived danger and may involve determining respondents’ attitudes to the severity or likelihood of hazardous events. Because individuals, in comparison to experts, often lack the necessary basis (e.g. exposure information) for estimating risk, heuristic processes are usually applied.

Over the past several decades, social scientists have helped to illuminate dozens of social, psychological, demographic and contextual factors that influence perceptions of risk. While a person’s ability to estimate the risk of injury or harm has been extensively studied, in relation to technological risks such as nuclear
power (Slovic, Fischhoff & Lichtenstein, 1980), there have been comparatively fewer studies of risk perception in relation to workplace accidents.

In the transport field, the concept of risk perception has received increasing attention in traffic safety research of both car (Brown & Groeger, 1988) and motorcycle driving (Mannering & Grodsky, 1995), with the purpose of developing accident countermeasures. However, within the aviation industry there have been only a few studies (O’Hare, 1990; Moses & Savage, 1989) that have examined the estimation and acceptance of risk by pilots, and whether perceived risk relates to accident causation.

Factors influencing perceived accident risk

The factors that influence perceived accident risk have been extensively studied in the traffic safety field. While studies of risk perception have varied widely in their theoretical and empirical base, results have consistently shown that the majority of drivers tend to believe themselves to be more skilful and safer than the average driver (McCormick, Walkey & Green, 1986; Finn & Bragg, 1986; Mathews & Moran, 1986; and McKenna, Stainer & Lewis, 1991). According to Mannering and Grodsky (1995) and Dejoy (1989), one behavioural tendency that has been noted in a variety of studies is that an individual’s perception of risk is often influenced by unwarranted optimism.

What seems clear from the literature is that an individual’s perception of risk is strongly influenced by a number of biases which include a general tendency to underestimate one’s own likelihood of accident involvement and a lack of
awareness of true accident probabilities. Therefore, it is not surprising that research studies tend to find a discrepancy between perceived and actual accident likelihood (Mannering & Grodsky, 1995).

Within the automobile traffic arena there have also been a number of studies examining the relationship between individual risk appraisal and accident causation (e.g. McCormick, Walkey & Green, 1986; Goszczyńska & Roslan, 1989). However, O’Hare (1990) suggests that within the aviation industry the literature on pilot decision making has not adequately addressed how well pilots are informed about the risks and hazards associated with flying. Furthermore, there have been no aviation studies examining the perceptions of safety hazards of other occupational groups (e.g. maintenance staff, cabin crew, ground staff). The need for this additional research is strengthened in the light of the recent trend within the aviation industry to move away from pilot error as the focus of understanding accident causation to the organizational or systemic approach (Reason, 1997; O’Hare, In press) which emphasizes organizational hazard recognition and safety prevention.

The aims of the present study were:

1. To compare subjective estimates of risk and perceived hazard among airline employees with worldwide airline accident statistics.
2. To determine whether there were any differences in perceived severity and perceived likelihood of occurrence of various aviation safety hazards between different occupational groups in the same airline.
Method

Participants

A major commuter/regional airline operating on the eastern seaboard of Australia agreed to participate in the study. The airline employs approximately 320 staff across five operational bases. One hundred and eighty employees working in three of the airline’s bases participated in the study. The sample included airline pilots (Captains and First Officers), Flight Attendants, Maintenance Engineers and Ground Staff. Participants were requested to complete a risk perception questionnaire prior to them participating in a safety focus group. One hundred and fifty-three questionnaires were returned giving a response rate of 80%.

Measures

The International Civil Aviation Organisation’s (ICAO) Accident/Incident Reporting System (ADREP) (ICAO, 1987), was used to compile a list of the most commonly occurring aviation safety hazards in commuter/regional aircraft operations. The ICAO ADREP database contains all recorded accidents investigated by its member government safety authorities throughout the world. Each member signatory is required to report to ICAO information on all aircraft accidents which involve aircraft of a maximum certified take-off mass of over 2,250 kilograms. This is in accordance with ICAO’s Aircraft Accident Investigation Policy, Annex 13 (ICAO, 1987). Participating member countries include Australia’s Bureau of Air Safety Investigation (BASI), the United States National Transportation Safety Board (NTSB), the United Kingdom’s Aviation Accident Investigation Bureau (AAIB), the
New Zealand Transport Accident Investigation Commission (TAIC) and Canada’s Transportation Safety Board (TSB).

A request was initiated to ICAO to provide a list of accident causal factors involving commuter/regional aircraft. According to U.S Federal Aviation Regulations, Part 135 of the Transport Act defines commuter airlines as regular public transport operators of aircraft with 30 seats or fewer. Aircraft over 30 seats are generally considered major airlines operating jet transport aircraft and come under Part 121 of the Act.

Information was provided on aircraft accidents for the period 1990 to 1996. The term “accident” is defined in ICAO’s Annex 13 as when:

- A person is fatally or seriously injured; or
- The aircraft sustains major damage or structural failure; or
- The aircraft is missing.

The ADREP system classifies aircraft accidents according to a number of rules. An accident or occurrence is coded according to events, descriptive factors and explanatory factors. This relationship is illustrated in Figure 1.

(Fig 1 about here)

An accident generally involves several related events. For example, an engine failure then collision with terrain. The occurrence of one event may or may not lead to another. The ADREP system allows for the coding of up to five events per accident. Events are also classified according to the phase of flight (e.g. take-off, landing or cruise). For each event, multiple descriptive and explanatory factors are assigned.
Descriptive factors describe in detail what happened in a given event and consist of two parts: a subject and a modifier. The subject provides information on what was involved and the modifier gives the details. For example, in the case of an aircraft training accident during an engine failure simulation exercise, a descriptive factor might be an “engine” or a “powerplant” and a modifier may be a “simulated failure”.

Explanatory factors explain why the event occurred and can be used to determine what preventative action may be required. They generally consist of three parts: the title or designation of an organisation or person that was responsible for the event; a subject that identifies the area of involvement; and a modifier that shows the nature of the involvement. For example, the organisation or person may be a “pilot”, the subject “knowledge” and the modifier a “lack of”.

The advantage of using explanatory factors over descriptive factors, as an information source, is that they go further into the event and attempt to account for why it happened. However, explanatory factors are only useful in situations where the involvement of organisations or persons related to the occurrence can be established. In addition, explanatory factors do not allow the coding of technical difficulties or failures because responsibility may not be able to be determined.

With these limitations in mind, descriptive factors were used as a source to construct a list of aviation safety hazards. Descriptive factors were selected on the basis of their frequency of occurrence within the statistics. The frequency of occurrence was the total number of accidents in which they were implicated. Those
descriptive factors that were implicated in less than 10 accidents in the 1990-1996 period were not included.

A final list of 22 safety hazards was developed which represented the most common contributing factors in terms of commuter/regional aircraft losses and passenger fatalities. These hazards are shown in Figure 2.

(Fig 2 about here)

A risk perception questionnaire was then constructed on the basis of these safety hazards. The questionnaire required respondents to rate each of the hazards according to their potential to affect the safety of fare paying passengers carried by their airline. Each hazard was rated according to its hazardousness (the potential for the hazard to result in damage, injury or death), and the likelihood of it occurring within the airline environment. Consistent with other risk perception studies of workplace hazards (e.g. Young, Brelsford & Wogalter, 1990; Young & Laughery, 1994; Martin & Wogalter, 1989) a nine-point Likert rating scale response format, with end points of 0 and 8, was used. For hazardousness, these end points represented “not hazardous” (0) to “extremely hazardous” (8). For likelihood, 0 represented “not likely to occur” and 8 “extremely likely to occur”.

**Results**

The initial aim of the data analysis was to determine the reliability of the risk perception measure. Reliability analysis resulted in a Cronbach’s alpha reliability coefficient of .921 for the hazardousness ratings and .933 for the likelihood ratings. The means and standard deviations for rated hazardousness are presented in Figure 3.
Results indicate that the two hazards rated by respondents as having the greatest potential to result in damage, injury, or death were those relating to the failure to correctly maintain the essential flight control and powerplant systems of an aircraft. In addition, weather in the form of windshear and thunderstorms, were also perceived as particularly hazardous. Interestingly, a systemic factor – poor flight crew training was also identified as one of the greatest hazards in the commuter/regional airline operation.

The results for perceived likelihood are presented in Figure 4. The three hazards which were perceived as most likely to occur were all weather-related (turbulence, icing and thunderstorms) with windshear rated as sixth in the listing. Both the perceived hazardousness ratings and the perceived likelihood ratings are dominated by external factors, such as weather and maintenance, which are beyond the direct control of flight crew operations.

Population normality and homogeneity of variance assumptions underlying ANOVA were tested and revealed that the hazardousness and likelihood data did not violate either assumption. Therefore, mean hazardousness and likelihood scores were compared across different occupational groups within the airline (Pilots, Flight Attendants, Maintenance and Ground Staff) to identify possible differences in perceptions. Results of a one-way ANOVA indicated no significant differences in the perceived hazardousness of various aviation safety hazards. Similarly, the
one-way ANOVA results for likelihood also showed no significant differences between the groups.

A Pearson’s correlation was conducted between the hazardousness and likelihood scores to determine if there was a significant relationship. A significant negative relationship was found \( r = -.40, p < .05 \). A correlation was also conducted to examine the relationship between the ADREP ranked data and the perceived hazardousness and likelihood ratings. However, because the ADREP data was positively skewed, thus violating the normality assumptions of Pearson’s r, non-parametric tests were undertaken. Results of a Spearman’s rho indicated there was no significant relationship between the ADREP ranking and hazardousness rating \( \text{rho} = -.091, p > .05 \) or between the ADREP ranking and likelihood rating \( \text{rho} = -.194, p > .05 \).

**Discussion**

Using the ICAO ADREP system, 22 safety hazards for commuter/regional airline operations were identified. Flight crew performance was a factor in four out of the five (80%) most frequently cited factors. When groups of employees of a major commuter/regional airline rated the perceived hazardousness and perceived likelihood of these same events, there was hardly any correlation with the objective influence of these factors. Thus subjective perceptions seem to diverge markedly from the objective information. No differences in perceptions were found as a function of occupation (e.g. maintenance versus flight crew) within the airline.
In comparing the hazardousness and likelihood ratings of respondents in the present study to the actual accident statistics from ICAO, some interesting conclusions can be drawn. The ICAO data reveals that human factors such as poor flight crew judgement and incorrect operation of equipment by flight crew are the most common factors in accidents. Weather-related factors feature towards the bottom of the ICAO list, in terms of their relative contribution to aircraft accidents. This is in direct contrast to the hazard rankings in the present study. In other words, the risk perception of participants in this study, regarding the hazardousness and likelihood of aviation safety hazards, are not reflected in the actual accident statistics.

The relationship between risk perception and actual accident or incident frequencies has been studied by Dunn (1972) who compared the risk estimates of chainsaw operators with reported accident frequencies and found little correlation. Zimolong (1979) also studied the relationship between subjective risk estimates of railway shunters and the frequency of minor, severe and fatal injuries, finding little relationship between objective and subjective indicators of risk.

Studies that have examined the relationship between risk perception and aviation safety (Moses and Savage, 1989; Braithwaite, 1998) have found that aircrew tend to perceive that the greatest hazards in their work environment are other people or weather-related dangers. There also appears to be a sense of fatalism about hazards that are unfamiliar (e.g. the unpredictable nature of clear air turbulence) or beyond personal flight crew control (e.g. the quality of maintenance performed on the aircraft). These findings are supported by research that has
examined coping behavior in highly threatening situations. Coping behavior usually takes the form of defense mechanisms, such as withdrawal or fatalism (Nelkin & Brown, 1984; Monat & Lazarus, 1985).

As in the aviation studies cited above, the most commonly cited hazards by airline staff in the present study, were typically external factors outside direct flight and cabin crew control. For example, those hazards assessed as potentially most severe (hazardousness) were the inadequate maintenance of the aircraft powerplant (engine), flight control systems and fuel systems.

There are two possible explanations for these findings. Firstly, as the majority of the sample were comprised of flight and cabin crew, it may be possible that the high ratings given to these maintenance functions, may reflect distrust on the part of aircrew that these functions are being adequately conducted.

Secondly, an examination of psychological and risk communication research suggests that there are differences in objective versus subjective appraisal of risk. For example, research on attribution theory reveals that people tend to rate their successes based on inner qualities and their failures based on external circumstances that are perceived as beyond their direct control (Heider, 1944; Wiley, Crittendon & Bing, 1979). This is supported by the results of the likelihood ratings. Weather-related events, such as turbulence, icing and thunderstorms featured most prominently as those hazards most likely to threaten flight safety. As with the hazardousness results, these are factors that are beyond the direct control of flight and cabin crew, due to their somewhat unpredictable nature.
Furthermore, in the present study aircrew tended to underestimate their relative contribution to accidents and overestimate the contribution of others. This phenomenon has been extensively studied in the field of social psychology and is known as the fundamental attribution error (Heider, 1944). Other studies have shown that people rate their chances of being vulnerable to a wide range of health and safety hazards as particularly low when the threats are perceived as being controllable by personal actions (Weinstein, 1980; 1984; Sandman, 1993).

Further explanation for the disparity between subjective and objective estimates of risk in the present study, can be found in an examination of the risk management and risk communication literature (Sandman, 1993; Hance, Chess & Sandman, 1990; Grose, 1995) which, suggests that an objective assessment of risk on its own may not be appropriate. For example, Sandman (1993) argues that risk is a function of hazard and outrage (risk = hazard + outrage). “Hazard” is the real or objective risk and “outrage” is the subjective or “perceived” risk. Sandman suggests that the outrage component is real, and as much a part of risk as the hazard part of the equation. However, because outrage is usually seen as “soft social science” it is often overshadowed by more “technical” responses to risk management.

While largely applied in the chemical and nuclear power industries, researchers in the risk communication field have identified, “perceived loss of control”, as an important determinant of an individual’s attitude and appraisal towards different types of risks. These findings are similar to psychological research on attribution theory mentioned above. Other components which influence
perceived risk include, whether the hazard is voluntary or coerced, knowable or not knowable, fair or unfair, and if the process (or organisation) is responsive or unresponsive to individual concerns (Hance, Chess & Sandman, 1990; Sandman, 1993).

The results of the present study lends support to both risk communication research and the psychological literature on attribution, which recommends that any assessment of risk include the measurement of subjective risk appraisal. Because the risk perceptions of different occupational groups within the airline industry may not be easily dealt with by quantifiable risk ratios and accident rates, any communication system that aims to inform and reassure employees about the efficacy of company safety management efforts has to address more than just the likelihood of various outcomes and events. Education about the structure and reliability of the company’s approach to safety management, and subsequent management of identified risks, needs to be an ongoing effort. The presentation of specific information and/or reassurance about safety should be a management priority.

For example, since the level of risk in commercial aviation is already so small (according to accident statistics), it may be informative to communicate to employees the likely expenses required to achieve further reductions in a specific risk. If additional funds and energy are required to reduce the risk but the cost of flying increases, than employees are more likely to accept the risk, than continue to be pessimistic about the perceived lack of management care about their safety well-being. In short, acknowledging that an individual's appraisal of risk will not always
be based on technical explanations will provide managers with more opportunity to identify workplace hazards before they become incidents or accidents.

In summary, the findings of the present study reveal that any assessment of workplace risk must include and acknowledge both objective and subjective components. A safety program that facilitates greater group cooperation will enable management to increase their employees' sense of control and mastery of workplace hazards, while encouraging them to become more proactive about recognising and reporting safety problems. Therefore, the primary task for management in minimizing human error may be to find ways to channel employee reactions away from withdrawal or a poor sense of personal control, and instead aim for collective security with participative safety management activities.
References


Figure Captions

Figure 1. The ADREP coding system

Figure 2. Common worldwide aviation safety hazards for commuter/regional aircraft (1990-1996)

Figure 3. Rated hazardousness of specified events in commuter/regional operations

Figure 4. Rated likelihood of specified events occurring in commuter/regional airline operations
Turbulence
Poor staff supervision
Regulations open to interpretation
Poor equipment design
Inadequate manuals
Icing
Incorrect aircraft loading
Failure to inspect airport ground facilities
Poor flight crew procedures
Failure to correctly inspect airframe
Failure to follow aircraft maintenance check
Flight crew incorrect operation of equip
Failure to maintain fuel system
Poor flight crew training
Windshear
Thunderstorms
Landing gear failure
Poor AIS procedures
Handling aircraft outside standards
Poor flight crew judgement
Accident Factors
Perceived Hazardousness

Perceived Hazardousness
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