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ATSB RESEARCH AND ANALYSIS REPORT

Aviation Safety Research Grant B2004/0240/1

Quantitative Study

Organising for Flight Safety

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CONTENTS

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Abstract

The report presents the findings of an audit of the organisational arrangements existing in the flight operations divisions of eleven major airlines based in South East Asia and Australasia. The audit contributes to a wider study on aviation safety. The audit adopted as its framework the investigation of issues associated with human factors, culture, safety management systems, high reliability, organisational resilience, and benchmarking. It is argued that these factors are subject to influence by flight operations managers and that they have an impact on airlines' safety outcomes. The objective was to obtain information on 'the way things are done' in the flight operations departments of the participating airlines.

Results from the audit provide guidance on the norm that can be accepted for organisational arrangements and management processes of airlines that demonstrate successful aviation safety outcomes. At the same time, the research shows areas where further development may be possible.

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ABBREVIATIONS

ALAR	Approach and Landing Accident Reduction
ATC	Air Traffic Control
ATSB	Australian Transport Safety Bureau
AOC	Air Operator Certificate
CAIR	Checklist for Assessing Institutional Resilience
CEO	Chief Executive Officer
CRM	Crew Resource Management
FAA	Federal Aviation Administration
FOQA	Flight Operational Quality Assurance
GFT	General Failure Type
HRO	High-reliability or Highly Reliable Organisation
IATA	International Air Transport Association
IOSA	IATA Operational Safety Audit
LOSA	Line Operations Safety Audit
MESH	Managing Engineering Safety Health
QAR	Quick Access Recorder
SMS	Safety Management System
SOP	Standard Operating Procedure
TEM	Threat and Error Management

EXECUTIVE SUMMARY

Many factors contribute to an airline's safety record, some external to the organisation and others internal. An important internal contribution comes from the manner in which the company's flight operations are managed. This study addresses the organisational factors impinging on an airline's safety outcome that are subject to influence by managers in their flight operations divisions. Particular attention is given to evidence of the concept known as 'institutional resilience'.

Twelve major airlines in Australasia and South East Asia participated in the study. The study used a mixed method approach, incorporating both qualitative data (interviews) and quantitative data (audit). The qualitative approach used in-depth interviews, conducted with 36 senior managers in the twelve airlines. The quantitative approach comprised a self-reported audit of organisational management arrangements within each airline. The audit was conducted by means of a questionnaire sent to one senior manager in each airline. Eleven questionnaires were returned.

This report deals with the analysis of results from the audit.

The scope of the audit was determined by both the framework adopted for the study and by information gained during the preceding 36 interviews. The framework of analysis has six-parts: human factors, culture, safety management systems, benchmarking, and theory of high reliability and institutional resilience.

The results show both significant similarities and important differences between the airlines. Attention is given to differences between domestic and overseas airlines. The similar outcomes are useful as a normative guideline on the way airlines should address their management of safety. The differences provide a guide to further development by both airlines and researchers. The findings are discussed in detail at Section 5 of this Report.

The study identifies three areas suitable for further research. The first relates to further development of reactive and proactive measures that can indicate the state of an airlines' 'safety health'. When used in an appropriate combination, such measures should indicate changes in intrinsic safety levels and facilitate the prioritisation of remedial action. The next area builds on the first by investigating the development of a checklist, similar to the Checklist for Assessing Institutional Resilience (CAIR). A suitable checklist must appeal to the airlines in terms of its practical application. The third area is development of a process to improve the reporting rate of flight crew error.

1 INTRODUCTION

This report covers the second part of a study on the contribution to safety made by the flight operations divisions of major airlines. The study investigates organisational structures and management processes. This report presents the results and analysis of an audit of the organisational arrangements of eleven of the twelve airlines participating in the study. A subsequent report will cover the results of a qualitative analysis of 36 interviews conducted with senior managers in flight operations divisions of the twelve airlines.

Part 1 of this report reviews the literature, Part 2 states the objectives of the study, Part 3 describes the methodology, Part 4 presents the results, Part 5 gives the findings, Part 6 describes the limitations of the study, Part 7 provides recommendations for further study, and Part 8 provides a concluding comments.

1.1 The safety record of commercial air transport

Commercial air transport has achieved an impressive safety record in spite of the severe hazards that it confronts. Such hazards include flight in zero visibility, at transonic speeds, at altitudes where humans cannot survive without the aircraft's protective capsule, an imperative that fuel exhaustion invariably results in loss of life, and a high dependence on the actions of humans whose failings are seemingly inevitable.

Comparison with other transport modes suggests that air transport's safety record is outstanding, although quantification and comparison of safety levels can be problematic (ATSB 2003). The problem of ambiguous comparison derives from a complexity of issues such as the selection of appropriate activity bases[1], passengers' exposure to the different transport modes[2], and definitional issues[3]. While acknowledging these limitations, a comparison of road and air transport fatality rates in the USA for the year 2000 indicates that fatalities for highway accidents are approximately 400 times the number of fatalities attributable to airline accidents[4]. Barnett and Wang (1998, p.3), using data for the decade 1987-96, show that an individual airline passenger on 'First-World domestic jet flights' faced a fatality risk of one in eight million for a single flight. Putting this another way, they state that 'a passenger who took one such flight every day could on average go for 21,000 years before succumbing to a fatal crash'. Worldwide, the accident rate for the commercial jet fleet has continued to decrease in the past decade (Boeing 2004).

This safety outcome, achieved in an environment more hostile than that encountered by other transport modes, invites the question: what makes air transport so safe? From this follows another question: can aviation provide safety lessons transferable to other

1 For example, different results will arise where comparison is made on the basis of either completed journeys, or time of travel. The issue of ability to substitute transport modes is another limitation.

2 For example, some people have never travelled by air while the majority of the population travel regularly by ground transport.

3 Definitions of accident and incident commonly vary between legal definitions and common usage; definitions of 'fatal accident' vary according to the proximity of death to the time of the accident.

4 Boeing data accessed on website: <www.boeing.com/commercial/safety> on 12 June 2005.

transport modes or other hazardous industries? The research considers these questions and provides some answers that may find general application in other contexts.

1.2 Factors contributing to the safety record

A systems approach to flight safety is a useful way to analyse contributions made to air transport safety. System elements include the operating environment, aircraft, flight crews, operating procedures, and airline organisations. Hazards presented by the operating environment include adverse weather, aerodrome facilities, and air traffic control (ATC). Boeing (2004) reported that these factors contribute approximately 16% to commercial jet accidents[5]. Improvements to aircraft design and maintenance have made major advances in the past few decades. The Boeing report shows that aircraft maintenance, as the primary cause of accidents, is a minor 18%. The most significant primary cause of accidents, at 62%, is flight crew. In a 1998 Report, Boeing (1998) proposed a set of accident prevention strategies ranked by the importance of their contribution to recorded accidents. The four most important strategies involved improvement to flight crew procedures and skills. It appears that further improvement in aviation safety must come from research into improvement of the performance of flight crew.

However, the Boeing Study only reports on the observable primary causes of aircraft accidents. It does not show, therefore, the contribution to aircraft accidents that might be attributable to the aircraft operator. Airline managers play an important role in aircraft accident prevention. This is achieved, in part, by implementing processes and policies to improve the performance of flight crew. They also establish appropriate organisational structures and communication systems and manage resources along with devising and reviewing operating procedures.

1.3 Attention to organisational factors

Aviation safety regulators recognise the importance of organisational factors in the management of aviation safety. This is given effect by the issue of Air Operator Certificates (AOC) to airlines that meet criteria acceptable to the regulator[6]. Under penalty of legal sanctions, flight operations must not be conducted unless the operator holds a current AOC (Air Navigation Act 1988). This approach accepts that the organisation, through its policies, processes and resource management, exerts significant influence on the level of risk incumbent in its flight operations. Relevant literature includes Kennedy and Kirwin's (1998) acknowledgement of the significance of managerial and organisational failures in the causation of accidents and Reason's (1997) concept of 'latent conditions' in organisational accidents.

In addition to threatened legal and administrative action by regulators, airlines have other incentives to achieve levels of safety acceptable to passengers and to their

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5 These data were for the worldwide commercial jet fleet over the decade 1994-2003. Each factor is an identifiable primary cause of accidents.

6 In Australia, such conditions can include the appointment of acceptable persons to key management positions, acceptable organisational structures, suitable buildings and facilities, adequate numbers of suitable qualified and competent employees, suitable procedures and practices to control the organisation and acceptable financial performance.

communities. Such incentives include market discipline[7], insurance premiums and conditions, tort law and action by unions (Dannatt 2002).

Organisational factors significantly influence flight safety outcomes since managers bear responsibility for the development of policy and oversight of its implementation. Hopkins (2005, p.135), in concluding an analysis of acceptable risk contends that, 'the quality of management will have a major effect on risk'. In particular, top management and the management of flight operations, set policies on the overall acceptable level of risk for the organisation. Consequent polices and decisions include the selection of suitable aircraft types and installed protective and safety devices[8], routes to be operated, aerodromes to be used (or avoided), and flight operating procedures. Most importantly, management can influence the level of risk presented by human factors, acknowledged as the most significant contributor to accident causation (Maurino et al. 1995). Management sets and applies policies in relation to standards for recruitment of flight crew, subsequent training, assessment of ongoing competency, and dismissal of individuals who do not achieve or maintain the set standards. Management also decides on rostering systems that affect levels of crew fatigue, in turn impacting on the level of human error (Helmreich & Merritt 2000).

Consequently, management has a large influence on organisational culture, which in turn plays a significant role in the safety outcomes of an airline. Perhaps most importantly, senior management makes critical policy decisions on the balance between 'protection and production' (Reason 1997), laying the foundation for resultant safety culture. Such policy guides organisational behaviour when members are making day-to-day decisions on the priority given to safety when this conflicts with 'getting the job done'.

In summary, investigation of the contribution of organisational factors to flight safety should involve consideration of the areas where management has an influence on the outcome. Appropriate topics for analysis are human factors, the role of culture, safety management systems, high reliability theory, institutional resilience, and benchmarking.

1.4 Contribution of human factors

In recognition of the significant contribution by flight crew to airline accidents, industry and academia have increased their efforts to understand human factors[9], and construct defences against human error. Development of specialised training for flight crews in so-called 'soft skills', was driven by accidents such as the 1977 collision of two B747 on the ground at Tenerife with the loss of 583 lives. 'Soft skills' training focused initially on inter-crew coordination and communication as a means of improved sharing of situational awareness and assertiveness of junior crew members.

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7 Market discipline is a term used by economists to describe the effect when a firm's products or services do not meet the expectations of their customers. Either the expected outcome is that customers withdraw their patronage and the firm has to improve the quality of its product or it fails to make a profit with the likely result that it withdraws from the market. Where the product quality is related to flight safety, market discipline exerts a strong influence on airline management.

8 Examples are Enhanced Ground Proximity Warning Systems (EGPWS), TCAS II, auto-flight systems, auto-landing systems, and weather radar.

9 Lee (2002) proposes that 'human factors is concerned with understanding the performance capabilities and limitations of the individual human operator, as well as the collective role of all the people in the system which contribute to its output' p11.

The programs were referred to as Cockpit Resource Management or CRM training. The terminology was later revised to Crew Resource Management after a fatal 1989 accident involving an F28 aircraft at Dryden, Canada, demonstrated the need to include cabin crew in the program. This concept has been adopted by other high hazard industries including maritime and offshore oil production. Currently, the focus of aviation CRM training is on human error and its management. Understanding of the management of human error in the context of flight-deck operations is informed by the research of Helmreich et al. (2001) at the University of Texas who developed the Threat and Error Management (TEM) program. Other topical human factors issues include the management of fatigue, management of drug and alcohol addiction, and maintenance of flight crew technical skills[10].

To some extent, the contribution of human factors to accident causation is amenable to action by airline management. Managers are responsible for selecting suitable new pilots, for establishing training programs and for ensuring their continued competency as flight crew. Competency can be monitored by tests and observations and by means of recordings of flight parameters. Defences against human error such as error avoidance, error trapping and error mitigation can be implemented and strengthened by policies and procedures devised by operations managers.

1.5 The role of culture

Along with the growing interest in human factors, research has extended into the role of culture as a factor in aircraft accident causation. Writers commonly refer to the explanation given by Schien (1992, p.8-9), describing culture as 'the way we do things around here'. Although the term 'culture' is commonly used in management and academic contexts, there is sometimes a difference in the attribution of attitudes and behaviours to individuals as apposed to groups. Academics seem to agree that the focus should be on groups (Hopkins 2005; Reason 1997). Regardless, it seems to be generally accepted that culture and its behavioural outcomes are amenable to management intervention, 'leaders create cultures by what they systematically pay attention to' (Hopkins 2005, p.53).

Culture, in relation to safety, is sometimes deconstructed into a number of subsets. These 'components' of culture include national culture, organisational culture, professional culture, safety culture, flexible culture, learning culture, reporting culture and just culture. Helmreich and Merritt (1998) discuss the interaction of national culture, professional culture and organisational culture on flight crew behaviour and the consequent positive and negative safety outcomes.

Safety culture, as a concept, arose from inquiry into the 1986 nuclear power plant disaster at Chernobyl. Reason (1997, p.194) proposes that a useful definition of safety culture is that provided by the UK Health and Safety Commission, which he quotes:

> The safety culture of an organisation is the product of individual and group values, attitudes, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety programs. Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventative measure.

10 In comparison with 'soft skills', 'technical skills' are those skills or competencies necessary to fly an aeroplane. These are sometimes referred to as 'stick and rudder' skills.

Hopkins (2005) questions the appropriateness of the term 'safety culture' suggesting that there are circumstances where the concept of a 'culture of safety' is more appropriate. This approach suggests that 'safety culture' rather than presenting as an identifiable subset of organisational culture is simply another facet of the organisation's culture.

Pidgeon (1998, p.208) notes that within an organisation, different styles of management often evolve between divisions and this can produce differing safety sub-cultures. He uses the example of civil aviation and the divisions between flight and ground managers to argue that different levels of concern can exist in regard to safety issues:

> … in some instances an incident may be deemed serious by operational personnel but the management to whom it is reported do not allocate a similar priority to investigating the aetiology of incidents, perhaps merely seeking to lay blame for the event.

'Safety climate' is a term sometimes used to describe the attitudes and behaviours of members of an organisation, although clarifications of the generally accepted meanings of 'safety culture' and 'safety climate' await general agreement (Guldenmund 2000; Cooper 2000). Hale (2000) proposes that the concepts of safety culture and safety climate are so intertwined in common practice that any differences should be ignored. A study by the ATSB (2004) on safety climate factors associated with Australian commercial pilots identified four factors important to aviation. The factors were *management commitment, training, equipment and maintenance, rules and procedures*.

Reason (1997) further introduced a number of components, or perhaps characteristics, of a safety culture. These he describes as 'informed culture', 'reporting culture', 'just culture', 'flexible culture' and 'learning culture'. Each component is important to the achievement of desired safety outcomes. He proposes that management has a large influence on the development of each of these component cultures. Reason also distinguishes between 'just culture' and 'no blame' culture. In a 'just culture', errors resulting from avoidable and unnecessary violations may be subject to sanction, whereas 'no blame' attaches to unintended errors.

Hudson (2003) introduces a concept of maturation of safety culture within organisations. With increasing 'informedness' (sic) and increasing trust, Hudson proposes that safety culture can evolve through five levels. In ascending order of evolution, these are Pathological, Reactive, Calculative, Proactive and Generative. At the lowest level, safety management adopts the view, 'who cares as long as we are not caught'. The highest level occurs where the objective is, 'safety is how we do business around here'.

Although the aviation industry recognises the importance of safety culture, there appears to be little recorded evidence of effort within airlines to manage the development of culture or measure culture. Some attempts have been made in Australia to measure culture in the 'smaller' end of the aviation industry (Edkins 1998). By comparison, the high-hazard offshore oil and gas industry has attracted considerable research on the measurement of safety culture and safety climate (Mearns et al. 2003).

Absence of a 'culture of safety' (Hopkins 2005) or a strong 'safety culture' appears to be evident in incidents and accidents where pilots deliberately violate safety-related rules in order to achieve their flight schedules.[11]

1.6 Safety management systems (SMS)

An important accident-avoidance tool used by most airlines is the 'safety management system' (SMS). The UK Civil Aviation Authority (CAA 2002, p.2) defines an SMS as:

> … simply the systematic application of management processes to the problem of the hazards an organisation faces and the proof that the management system is in operation.

Aviation safety regulatory authorities commonly require the establishment of an SMS as a condition for their issue of an Air Operator Certificate (AOC). Despite regulatory enforcement, Hudson (2002) argues that SMS are justified on the basis that they make good business sense from the viewpoint of cost/benefit analysis.

A central function of SMS is the collection and analysis of safety-related data. Reason (1997) refers to research by Smith et al. (1988) which shows that a distinguishing feature of safe organisations is their possession of an adequate safety information system. The data are used to inform managers on new hazards, changes in safety trends, and provide a means of monitoring compliance with standard operating procedures. Important sources of data include reports submitted by employees, recordings of flight parameters and cockpit voice recorders, in-flight observations of crew performance, and audits. The importance of monitoring flight operations is highlighted by reference to Boeing's (1998) top three accident prevention strategies, which address flight crews' adherence to procedures.

Safety Management Systems cannot improve safety outcomes unless they are given life by the application of management action. Hopkins (2005, p.3) comments, 'investigations sometimes reveal that safety management systems are little more than sets of manuals occupying metres of shelf space and bearing little relation to what goes on in the workplace'. Gunningham (2004, p.246) comments:

> It is important to recognize that (SMS) processes are not an end in themselves. It is only the *quality* of **action** taken to manage (safety) that makes a difference to performance and not only particular structures or processes, and this itself is closely related to management commitment. For example, where either central or local management lacks the incentives to engage seriously in systematic (safety) management, the outcomes are likely to be disappointing (authors' emphasis).

Most SMS incorporate audits as a means both of data collection and of assurance of regulatory and policy compliance. Hale et al. (2002) comment that auditing systems are commonly developed by use of expert judgement rather than through use of an explicit management model. They claim that many commercial safety-auditing systems have no scientific basis and 'sell on their face validity'.

Whether the criticism of Hale and colleagues (2002) extends to audit programs such as IATA's IOSA system could be a subject for further research. The contribution to

11 Classic examples of such violations are descent below published visibility minima during instrument approaches or 'short cutting' procedures or checklists in order to make an on-time departure.

flight safety made by effective SMS appears to have attracted little attention from researchers.

An important function in effective management of safety is for the organisation to set in place a process to measure its 'safety health' by means of monitoring, what is described by Reason (1997) as the 'vital signs'. Effective sampling includes both reactive and proactive indicators. Reactive indicators use safety events that have taken place while proactive indicators are those which reveal the presence of 'latent conditions' or 'holes in defences'. Reason (1997, p.122) proposes that what matters is a 'principled attempt … to sample each of the six main dimensions …: culture, training, management, safety–related issues, procedures and technical factors'. This approach has led to the development of processes such as Tripod Delta (Hudson et al.1994), used mainly in the oil and gas industry, and MESH (Reason, 1995) which was developed for aircraft maintenance organisations. No similar systems or processes appear to have been developed for airline flight operations.

1.7 Highly reliable organisations

The past decade has seen developing interest in organisations that operate in high hazard environments and do so reliably in terms of low accident rates and uninterrupted service. The original research was associated with aircraft carrier operations in the US Navy, air traffic control (ATC) and the nuclear power industry (Weick & Sutcliffe 2001). Such organisations have been termed 'highly reliable organisation' or 'high-reliability organisation, (HRO). The significance of high reliability in these organisations is described by LaPorte and Consolini (1991, p.19) as:

> …some organisations must not make serious errors because their work is too important and the effects of their failures too disastrous. This is especially true with organizations that operate technologies that are very beneficial, yet costly and hazardous.

This description suggests that the findings of HRO research have application to airline operations.

Weick (1987, p.118) describes reliability as a 'dynamic non-event'. Thus, while an observer sees little change in the outcome, the stable outcome is achieved by continual change in the production process; 'what produces the stable outcome is constant change rather than continuous repetition' (Reason 1997, p.37).

The research shows that some organisations, operating at a high level of reliability in hazardous environments, exhibit unique identifiable characteristics (LaPorte 1996; LaPorte & Consolini 1998; Weick, Sutcliffe, & Obstfeld 1999; Weick & Sutcliffe 2001). One important characteristic of these organisations, identified by Weick and Sutcliff (2001), is that of 'mindfulness'[12]. Elsewhere described, as '… the mindset for reliability requires chronic suspicion that small deviations may enlarge...' (Weick 1987, p.118). This is interpreted by Reason (1997) as 'not forgetting to be afraid' or a preoccupation with failure. Hopkins (2005, p.14) argues that mindful organisations generate mindful individuals; presumably, these employees are 'risk aware'. Weick

12 An example of inadequate 'organisational mindfulness' is suggested in a report (ATSB, 2001) of an investigation into maintenance safety deficiencies by Ansett Australia. The question was raised "whether Australia's historically good aviation safety record led to a degree of complacency with the aviation safety system" (p 144).

(2001, p.279) provides an example of the importance of 'collective mind' on an aircraft flight deck; 'reliable performance may require a well-developed collective mind in (producing a) … complex, attentive system tied together by trust'. Development of 'collective mind' on the flight deck is addressed in the CRM training discussed earlier.

Weick and Sutcliff (2001, p.10) list five 'hallmarks' of 'mindfulness' seen in organisations that persistently have less than their share of accidents. These are:

- preoccupation with failure
- reluctance to simplify interpretations
- sensitivity to operations
- commitment to resilience
- deference to expertise.

The characteristic 'deference to expertise' in an HRO is demonstrated by the organisation's ability to restructure itself in times of stress. Reason (1997, p.213) describes this as a 'flexible culture'. When faced with abnormally critical situations, the required hierarchical, centralised structure changes so that decision making is passed to informal groups composed of relevant experts. 'Knowledgeable people self-organise into ad hoc networks to provide problem solving. These networks, which have no formal status, dissolve as soon as normalcy returns' (Weick et al. 1999, p.100). Many of the characteristics of HRO are observable in airlines. Reason (1997) quoting Laporte and Consolini (1991) describes patterns of behaviour in HRO which encourage:

- reporting errors without a lax attitude toward the commission of errors
- initiative to identify flaws in SOPs and nominate and validate changes in those that prove to be inadequate
- error avoidance without stifling initiative or (creating) operator rigidity, and
- mutual monitoring without counter-productive loss of operator confidence, autonomy and trust.

A condition for high reliability in complex systems is the need for work teams to include members with requisite variety in skills and work background (Weick 1987). Weick describes this as 'collective requisite variety'. The concept envisages that adequate performance by complex systems requires the human component to match the complexity and variety of the system.

The existence of a flexible culture or the ability of the organisation to adapt its hierarchical structure to give authority to expert teams is, to a certain extent, required from airlines in order to delegate responsibility for safety and reliability to flight crews. In general, the hierarchy in the organisation do not interfere with the real time, problem-solving issues faced during flight operations. Nevertheless, airlines are likely to vary in their willingness to meet such need.

1.8 Institutional resilience

The term 'institutional resilience', used in association with aviation and healthcare, appeared in the literature from 2001 onward. Although the term lacks clarity in

definition[13], the concept envisages that an organisation can have 'intrinsic resistance to its operational hazards' (Carthey et al. 2001, p.32). This contrasts somewhat with a similar term, 'organisational resilience', used to describe the ability of an organisation to 'bounce back' from an adverse event or disaster (Coutu 2002). On the one hand, the concept suggests the ability of the organisation to contain unexpected serious threats, or to have adequate defences against hazards (Reason, 1997), while the other concept suggests the ability to 'bounce back' after an adverse event and maintain operations although damage has occurred.

Wildavsky (1991, p.220) makes a distinction between organisations having resilience and those that deal with the unexpected by means of anticipation or pre-planning. The resilient organisations 'retain resources in a form sufficiently flexible – storable, convertible, malleable – to cope with whatever unanticipated harms might emerge'. Such resources are perceived not as stores of 'organisational slack', but are gained by assembling people with diverse knowledge and talent, through development of an organisational mindset of wariness, and developing a culture of reliability where employees believe that they will 'keep the show on the road' despite the unexpected. Weick and Sutcliff (2001, p.178) propose that the resilient organisation 'maintains an ongoing commitment to improve self-knowledge, relational knowledge, content knowledge, and capabilities to act thinkingly'.

There are obvious similarities in these descriptions of resilience to characteristics of HRO. This suggests that the concept of 'resilient organisations' might be another way of describing HRO. Differences might have their foundation in the system of reasoning used in their development. HRO theory is the outcome of inductive reasoning based on observations of reliable organisations while 'resilience' appears to be the outcome of deductive reasoning.

Reason (2001) developed a 20-item checklist for assessing institutional resilience in aviation organisations. This was published in CASA's magazine 'Flight Safety Australia' – a copy is in the Attachment. A similar version of this checklist was developed for use in the healthcare industry (Reason &Wreathall 2000; Carthey, de Leval, & Reason 2001).

Development of the 'resilience' checklists has association with Reason's (1997) model of organisations moving within a 'safety space' defined by two opposing nodes, one of increasing resistance to organisational accidents[14] and the other of increasing vulnerability to organisational accidents. Reason proposed that organisations require 'navigation aids' to identify their position in 'safety space' and so prevent 'backsliding' into the area of vulnerability. Carthey, de Leval and Reason (2001) suggest that the checklist provides useful guidance for measurement of resilience in healthcare organisations.

The checklists for institutional resilience were developed on the premise that 'cultural drivers' are required to maintain resistance to organisational accidents. Reason (1997, p.113) refers to Mintzberg's (1989) concept of top management being the strategic apex which provides the cultural driving forces of commitment, competence and

13 James Reason, in personal correspondence during 2004, commented that the term 'resilience' may not be a good descriptor of the concept. He commented that the term 'safety health seems closer to the mark'.

14 Reason defines an organisational accident as '…the comparatively rare, but often catastrophic, events that occur within complex modern technologies such as … commercial aviation …' (Reason, 1999) p1. Many, if not most, aircraft accidents occurring in commercial air transport might be regarded as 'organisational accidents'.

cognisance (the three Cs) necessary to maintain an appropriate position in 'safety space'. Other references by Reason (2001) and Carthey, de Leval and Reason (2001) integrate these three cultural drivers with four organisational principles, being: philosophy, policies, procedures and practices (the four Ps). Reason, using a matrix with the three Cs and the four Ps along the two axes, develops nine sets of indicators of organisational resilience. These nine indicators have additional subsets, which Reason and others appear to have used to develop the 20 items in the checklists.

Since its publication in 2001, the aviation checklist seems not to have attracted a similar level of interest to that shown in the checklist developed for the healthcare industry. Little evidence is available of empirical research into the checklist's use or its validation, although the concept of institutional resilience has obvious application to airlines. There appears to be no evidence that airline managers have adopted the concept of resilience or have attempted its measurement. A limitation of the practical application of the aviation checklist might be the qualitative nature of many the questions. This suggests that there is value in further development of an instrument that has attraction to airline managers.

1.9 Benchmarking

A question arises as to the currency of information available to managers to set in place the most effective protection against aircraft accidents. In Australia, there is expectation that managers will heed a legal dictum requiring that risk be reduced to 'as low as reasonably practicable' [15] (Turner v The State of South Australia 1982, High Court of Australia before Gibbs CJ, Murphy, Brennan, Deane and Dawson JJ).

Experience within the industry, together with ongoing technical development, produces constant change in terms of new ideas, processes, and equipment to reduce risk or improve safety. One method of staying abreast of change is the establishment of a formal process of benchmarking. This contributes to organisational learning, an organisational characteristic, which Turner and Pidgeon (1997) explain as being critical in avoiding 'man-made disasters'.

Benchmarking has been defined as '…a systematic and continuous measurement process; a process of continuously measuring and comparing an organisation's business practices against business leaders anywhere in the world to gain information which will help the organisation to take action to improve its performance' (Lema & Price 1995, p.14). Benchmarking provides a systematic means of collecting the latest information on 'industry best practice', which can form part of an airline's strategy to maintain its position in 'safety space'.

Audits are a common feature of airline organisations. When they are conducted by appropriately experienced external agencies, they might provide the additional benefit of a surrogate benchmark of the organisation against 'industry best standard'. As an example, IATA's audit program, IOSA, should provide that benefit[16].

The literature however, provides little evidence of airlines adopting formal processes of benchmarking, although auditing is common practice among the major carriers.

15 'Where it is possible to guard against a foreseeable risk which, though not perhaps great, nevertheless cannot be called remote or fanciful, by adopting a means which involves little difficulty or expense, the failure to adopt such means will in general be negligent.'

16 Information on IATA's IOSA program is available from <www.iata.org/whatwedo/auditing1.htm>.

2 OBJECTIVE

The objective of the study was to investigate those organisational structures, management processes and procedures adopted by major airlines, which are intended to address the safety of flight operations. Particular attention was given to the concept known as 'resilience'.

The study was limited to airlines operating large aircraft with seating capacity of 100 seats or more. The expectation was that organisational arrangements for these airlines would differ from operators of smaller aircraft. This is the likely outcome of greater attention given by the media and regulators to safety incidents involving large numbers of passengers. It is also likely that this category of operator has substantial assets thus supporting more complex management structures. No attempt was made to distinguish between 'low cost operators' and others, although this is a dimension that can be considered in further research.

Safety may be conceptualised as a component of the product produced by airlines[17]. The product in this case, is safe, reliable and rapid transportation. Contributions to the safety component of the product come from both the airline and external agencies. The external agencies include safety regulators, aircraft manufacturers, providers of air traffic services, aerodrome operators, fuel suppliers, and meteorological forecasters. Within the airline, contributions to safety come from a number of stakeholders including maintenance divisions, pilots, ground handlers and security staff. Other internal safety contributions derive from organisational management. These inputs provide the focus of this study and include organisational structures; management systems; operating policies; development of operating procedures; management of resources; and nurturing of appropriate organisational cultures. This study focussed on such arrangements in place within the flight operations divisions of the airlines.

This report presents the results of an audit of the participating airlines. The audit was intended to identify the arrangements used by major airlines to manage flight safety. Another objective was to see if Australia's airlines differed from neighbouring airlines and if so, to identify the areas of difference. A further area of interest was to investigate whether airlines attempted to produce measures of safety and if so, what parameters were measured and what use is made of the information.

The objective of the study excluded any attempt to address the norms imposed by State or International law, regulation, or convention.[18]

17 The concept of safety as a component of the product of air transport firms was provided by Professor Ian Savage, an economist at Northwestern University, Ill USA, during conversation in 2000.

18 For example, *Australia's Civil Aviation Act 1988* and the Annexes to the Chicago Convention of the International Civil Aviation Organization (ICAO).

3 METHODOLOGY

Twelve major airlines in Australasia and South East Asia participated in the study. Five airlines were based in Australia and the others were based overseas. Most of the airlines conducted international operations and, with the exception of one airline, operated into or within Australia.

The study utilised a mixed method approach, incorporating both qualitative data (interviews) and quantitative data (audit).

The qualitative approach used in-depth interviews conducted with senior managers in operations departments of the twelve airlines.

Interviews were held with 36 senior managers. The managers were responsible either for the standards of line operations or for safety management. They occupied positions with titles such as General Manager Operations, Fleet Manager, Chief Pilot, General Manager Flight Safety, or Head of Group Safety. Since most of the line operations managers were current line pilots with flying duties taking them away from the office, it was not always possible to plan interviews with specific managers. Transcripts of the interviews are being analysed using qualitative methods and the results are not addressed in this report.

Designed as an adjunct to the qualitative research, the quantitative research used an audit of organisational and management arrangements within each airline. The self-reported audit was conducted by means of a quantitative survey instrument. The questions were guided by the theoretical framework outlined in this report together with information gathered during the interviews.

One questionnaire was sent to a senior manager in each airline. Eleven were returned. Some respondents did not answer all of the questions. This may be the outcome of either oversight or reluctance to provide the information. A compounding problem with research in this area is that airlines are cognisant of potential exposure to legal liability or regulatory intervention. The researchers were consequently aware, and made aware, of the airlines' need and requirement for confidentiality.

4 RESULTS

The results are presented in Tables 4.1 to 4.6 in the order adopted for each item of the format for analysis. Reporting is by exception with only the 'yes' answers shown.

Conventions used in the tables are that numbers of missing or uncertain responses are shown in the column headed '**n**'. The column headed '**% yes Tot**' show the overall percentage of 'YES' responses exclusive of missing or nil responses. The columns headed '**Nos. yes**' show the numbers of 'YES' responses. This is further divided into returns from domestic airlines (**Dom**) and overseas airlines (**Int***). To facilitate comparison, the returns from the overseas airlines have been factored to account for the differing number of domestic and overseas airlines in the sample (5 versus 6) by multiplying the results in the Int* column by 5/6. Comparison of the numbers in these two columns must take account of the fact that there may be differences in the levels of nil returns ('**n**') for each of the two groups. While presentation of the data as a percentage of valid returns would overcome this error in comparison, the use of percentages introduces other distortions.

4.1 Contribution of human factors

The concept of human factors was reviewed in section 1.4 of this report. Questions associated with the management of human factors are shown in Table 4.1, dealing with selection and termination of pilots, achievement and maintenance of competency standards in 'soft' skills, and monitoring of flight crew performance.

Items relating to 'selection and termination of pilots' provide information on policies associated with the selection of pilots. This is likely to translate into crew competency in line operations. Other questions in this section are intended to assess the degree to which airlines divest themselves of 'non-performers'. Having regard to periodic shortages of pilots in the recruitment market and of the high cost of training, there are strong incentives to retain pilots who do not demonstrate necessary standards of competency.

Items addressing 'management of soft skills' are intended to provide data on the extent to which airlines approach the training of 'soft skills' and are current in their knowledge of new developments relating to threat and error concepts. Questions on error management were included due to their relevance to organisational resilience.

Questions grouped under 'monitoring of line performance' endeavoured to measure the extent to which airlines monitor in-flight crew performance beyond the regulatory requirements of 'route checks'. The use of FOQA to monitor trends in areas such as flight path accuracy has received wide acclaim (Flight Safety Foundation, 1998) and associated questions endeavoured to measure its level of acceptance by the airlines.

Table 4.1

Question Topic	n	% yes Tot	Nos. 'yes'	
			Dom	Int*
Selection and Termination of Pilots – Q 4.2 and Q 4.3				
Specified (documented) criteria for selection of new pilots	0	91	5	4.1
Some recruited pilots fail initial type/line training	0	91	5	4.1
Some First Officers failed command training on first attempt	0	82	4	4.1
Any Captain(s) terminated in last two years due loss of competency or other suitability criteria	1	50	2	2.5
Company program to assist pilots with human factor (personal) problems	0	91	4	5
Management of 'Soft Skills – Q 4.1.1 and Q 4.1.2				
CRM: Company-developed training program	0	91	4	5
Training for pilots only	0	27	1	1.7
Syllabus reviewed in last few years	0	91	4	5
Significant number of non-national pilots in company	0	45	0	4.1
English standard language on flight deck	1	100	4	5
Pilots trained on error avoidance, trapping and mitigations	0	91	4	5
Company developed training program {error training}	0	91	4	5
Adopted policy to use terminology 'monitoring pilot' for pilot-not-flying (pnf)	0	18	0	1.7
Monitoring of In-flight Performance – Q 1.7 (part) Q 3 (part)				
LOSA been conducted	0	100	5	5
QARs/FOQA analysis conducted	1	90	4	4.1
(i) All flights in company analysed	2	89	4	3.3
(ii) Is analysed data de-identified	2	100	4	4.1
FOQA data used to improve rate of stabilised approaches	1	90	4	4.1

** Results of 'Int' are factored to assist direct comparison with 'Dom' – for explanation refer commencement of Results section.*

4.2 The role of culture

Discussion on culture was provided in Section 1.5 of this report and items are outlined in Table 4.2. These items were not intended to constitute an audit of safety culture. They simply investigate the self-reported perceptions of the extent to which management consciously attempts to influence safety culture and/or any measure of culture within the division. The items also investigate whether Reason's concepts of 'just culture' and 'reporting culture' are evident. Further, regular reporting of mistakes and errors is taken to be an indicator of trust, a characteristic of HRO (Section 1.7).

Table 4.2

Question Topic	n	% yes Tot	Nos. 'yes'	
			Dom	Int*
Management of culture – Q 5				
Is safety culture consciously managed	0	91	5	4.1
Are measures used for culture and/or safety climate	0	73	3	4.1
Trust, just culture and reporting cultures – Q 5				
Are pilots held accountable for incidents/accidents that are attributable to human error	2	0	0	0
Is there a policy which specifically states that violations affecting safety are not tolerated	0	91	5	4.1
Do pilots regularly report on their mistakes and errors	0	73	4	3.3
Production versus Protection Policies – Q 3				
Crews have written guidance on priority of safety over schedule	0	91	5	4.1
Departure delays due safety issues always accepted	0	100	5	5

** Results of 'Int' are factored to assist direct comparison with 'Dom' – for explanation refer commencement of Results section.*

4.3 Safety management systems

Questions associated with SMS (Section 1.6) are provided in Table 4.3. These questions seek to identify features of the SMS seen to be in place with each airline. Since SMSs are driven to some extent by the airline's safety regulator, a number of questions were added to explore relations between the airline and its regulator.

Table 4.3

Question Topic	n	% yes Tot	Nos. 'yes'	
			Dom	Int*
Senior Management's involvement – Q 1.1				
Board active in monitoring flight safety	0	91	5	4.1
CEO chairs a safety committee	0	55	4	1.7
Responsibility effectively with Flight Ops Managers	0	55	1	4.1
Corporate Safety Department – Q 1.3				
Independent corporate safety department established	0	82	4	4.1
Headed by current or past line pilot	0	73	3	4.1
Head reports directly to CEO or Board	0	73	4	3.3
Department conducts (i) investigations	0	46	3	1.7
(ii) analysis of all pilot reports	0	82	4	4.1
(iii) analysis of FOQA data	1	70	3	3.3
Numbers of dedicated staff:	3 to 45			

Table 4.3 (cont)

Question Topic	n	% yes Tot	Nos. 'yes'	
			Dom	Int*
Flight Operations Safety – Q 1.4				
Safety Officers appointed additional to Corporate Safety staff	0	64	3	3.3
Conducts investigations of safety incidents	0	64	3	3.3
Meetings and Reports – Q 1.5				
Regular meetings held to discuss safety data	0	100	5	5
Committee prepares safety reports for CEO and/or Board	0	100	5	5
Documentation – Q 1.6				
Distributed Safety Policy Statement signed by CEO/ Director	0	100	5	5
Separate SMS Manual	0	64	5	1.7
Data Collection, Analysis & Storage – Q 1.7				
Types of reports submitted by flight crew:				
(i) Captain's voyage report (or similar)	0	91	4	5
(ii) Accident & incident reports	0	100	5	5
(iii) Hazard reports	0	91	5	4.1
(iv) Human factors reports	0	64	3	3.3
(v) Confidential reporting available	0	91	4	5
(vi) Others	5	83	2	2.5
Data from training reports used in safety analysis	0	09	0	0.8
Audits reports used in safety analysis	0	82	5	3.3
Safety data stored in electronic database	0	100	5	5
Trend analysis of safety data conducted	0	100	5	5
Feedback provided to individual reporters	0	100	5	5
Summary of incidents/accidents provided to all line-crew	0	100	5	5
Risk analysis – Q 1.8[#]				
Formal, documented risk assessments conducted	3	100	4	3.3
Risk analysis conducted for:				
(i) changed operating procedures	7	100	2	1.7
(ii) new aircraft types	7	100	2	1.7
(iii) new routes/terminals	7	100	2	1.7
(iv) newly identified hazards	5	83	3	1.7

Table 4.3 (cont)

Question Topic	n	% yes Tot	Nos. 'yes'	
			Dom	Int*
Safety Management System (SMS) Review – Q 1.9				
Process documented	1	80	4	3.3
Conducted regularly	1	80	4	3.3
External Auditor	1	50	4	0.8
Audits – Q 1.10				
Internal compliance audit program in place	1	90	4	4.1
External audits conducted by:				
(i) Regulator	1	100	4	5
(ii) Code share/ alliance partner	1	70	2	4.1
(iii) IOSA	1	60	1	4.1
(iv) Boeing and/or Airbus	1	50	1	3.3
Relationship with regulator – Q 7				
Regulator's Inspectors participate in flight operations	0	100	5	5
Regulator perceived as effective	0	91	5	4.1
Relationship with regulator satisfactory	0	100	5	5

** Results of 'Int' are factored to assist direct comparison with 'Dom' – for explanation refer commencement of Results section.*

[#]A formatting error in the questionnaire introduced an error to some responses sent and returned by email, thus the results to Q1.8 must be treated with caution.

This section on SMS contains the majority of the questions in the survey. This reflects the principal objective of the study which is to examine the organisational arrangements of flight operations divisions of major airlines with specific attention to the organisational structures, processes and procedures that are expected to have an influence on flight safety.

4.4 High reliability

Discussion on Highly Reliable Organisations (HRO) is at section 1.7 of this Report. Questions associated with reliability are shown in Table 4.4. It should be noted that many of the characteristics of HRO, such as 'mindfulness', 'trust', and 'flexibility', are not represented in this questionnaire. They are instead explored in the parallel qualitative study.

Table 4.4

Question Topic	n	% yes Tot	Nos. 'yes'	
			Dom	Int*
Indicators of flexible culture – Q 3 (part)				
'Go-arounds' due to unstabilised approaches always accepted	0	91	5	4.1
Pilot-initiated diversions always supported by management	0	100	5	5

** Results of 'Int' are factored to assist direct comparison with 'Dom' – for explanation refer commencement of Results section.*

4.5 Institutional resilience

A discussion on institutional resilience is provided in Section 1.8 of this report and associated items are outlined in Table 4.5. Items in the CAIR checklist cover, and indeed define, the characteristics of 'organisational resilience'. As explained previously, answers to some questions in the CAIR Checklist require a qualitative methodology for further investigation and this has been undertaken in a parallel study. The questions in Table 4.5 seek to identify processes that might be in place to 'sample the vital signs' of the organisation.

Table 4.5

Question Topic	n	% yes Tot	Nos. 'yes'	
			Dom	Int*
Measurement of risk levels – Q 2				
Does company produce periodic quantitative measure(s) of flight operations risk levels	2	78	3	3.3
What is measured/tracked:				
(i) Numbers of safety incidents	1	90	4	4.1
(ii) Number of crew reports	1	80	4	4.1
(iii) FOQA analysis	2	89	3	4.1
(iv) Crew training/checking results	1	60	2	2.5
(v) Audit results	1	90	4	4.1
(vi) Crew fatigue	2	44	1	2.5
(vii) Safety culture	1	70	3	3.3
(viii) Aircraft 'go-around' rate	1	30	1	1.7
(ix) Flight 'diversion' rate	2	56	3	1.7
(x) Other	11	00	0	0
Results presented to CEO/Board	1	90	4	4.1
Process in place to prioritise hazards (risks)	1	90	4	4.1

**Results of 'Int' are factored to assist direct comparison with 'Dom' – for explanation refer commencement of Results section.*

The questions on 'measurement of risk level' satisfy a secondary interest of this study which was to investigate any measures of safety (risk level) in use within the airline and whether these measures are used in reports to senior management as indicators of change in the airline's intrinsic level of safety. This is in line with Reason's (1997) concept of 'navigation aids' necessary for organisations to locate their position within 'safety space' and determine the effectiveness of the organisation's 'driving forces' to maintain a position of optimum resistance to organisational accidents.

4.6 Benchmarking

It is argued that external audits may be a surrogate for benchmarking (Section 1.9); thus questions on external audits are repeated and presented in Table 4.6.

Table 4.6

Question Topic	n	% yes Tot	Nos. 'yes'	
			Dom	Int*
Benchmarking – Q 6				
Is there a formal policy to conduct benchmarking	1	30	3	0
Do company representatives attend international safety-related conferences	0	91	4	5
External consultants used to improve safety	1	30	1	1.7
External Audits – Q 1.10 (part)				
Conducted by:				
(i) Regulator	1	100	4	5
(ii) Code share or alliance partner	1	70	2	4.1
(iii) IOSA	1	60	1	4.1
(iv) Boeing and/or Airbus	1	50	1	3.3

** Results of 'Int' are factored to assist direct comparison with 'Dom' – for explanation refer commencement of Results section.*

5 FINDINGS

The findings are reported within the framework used in the preceding parts of the report, that is: human factors, culture, safety management systems (SMS), high reliability, organisational resilience and benchmarking.

5.1 Human factors

Questions Q 4.2 and Q 4.3 were expected to provide an indication of the rigour of standards applied to the selection and training of pilots, and monitoring of their ongoing competency. The results suggest that application of crew competency standards by all the participating airlines is uniformly rigorous. This is demonstrated by responses showing that some pilots commonly fail their initial training, some experienced pilots fail tests for promotion and, to a lesser extent, some captains are terminated due to failure to maintain standards. Where an individual response for termination of captains is lower than the norm, this is probably influenced by the infrequency of the event combined with the size of the airline together with other factors such as age profiles of the pilot cohort, staff turnover and the company's rate of expansion. The overseas airlines had a slightly higher response to termination of captains. The data in Table 4.1 show that it is common for airlines to have a formal program in place to assist pilots experiencing personal difficulties that might impinge adversely on their flight technical competency.

Questions Q 4.1.1 and Q 4.1.2 provided data on the airlines approach to the training of 'soft skills' such as CRM and management of human error. Since research has shown that accuracy of communication on the flight deck is a risk factor, two questions addressed likely sources of error – these are the mix of national cultures and the use of the English language. As expected, the overseas airlines were more likely to have significant numbers of non-national pilots. This may partially explain the apparent higher level of interest in training for 'soft skills' demonstrated by the overseas airlines in answers to Q 4.1.1 and Q 4.1.2 shown in Table 4.1.

Questions Q 1.7 (in part) and Q 3 (in part) were intended to show the effort applied to monitoring of normal line operations. The answers demonstrate that the sampled airlines have universally adopted the concept of 'line audits' or LOSA to monitor human error. Analysis of flight recorder data across the fleet is conducted by most of the sampled airlines but not all. Considering the safety benefits of FOQA analysis claimed by the Flight Safety Foundation, the 'no' and/or 'no response' returns were somewhat surprising.

5.2 Culture

Question Q 5 was intended to show the level of interest and/or awareness of the importance of managing safety culture. It was also intended to provide an indication of the existence of 'just cultures' and 'reporting cultures'.

The results show that most airlines believe that they consciously manage safety culture (91%). However, there is lesser interest in the use of measures of culture (73%). This might be explained by the ongoing debate in the literature regarding definition of the concept of safety culture and a consequent lack of an instrument that is generally accepted as providing an accurate measure of the concept.

The results show that most airlines are accepting of human error while formally

adopting a policy that safety violations are not tolerated – this is indicative of the existence of a 'just culture'. Regular self-reporting of error by flight crew occurs with 73% of respondents and the domestic airlines show slightly higher rates. This unexpectedly low number suggests that 'reporting culture' is an area worthy of further development.

Most airlines provide written guidance on the priority to be given to 'safety over production'. The expected emphasis on 'safety' is supported by the answers to question Q 3, which show universal acceptance by management of departure delays attributable to safety issues, and to an extent by the answers to questions on management's acceptance of pilot initiated diversions and 'go-rounds'.

5.3 Safety management systems (SMS)

Approximately half of the questions in the audit related to characteristics of the airline's SMS. This reflects the proportion of organisational effort made by airlines to manage safety through a formal safety department.

Question Q 1.1 investigated the level of involvement by top management in safety management. Most, but not all, of the surveyed airlines responded that the airline's Board was active in monitoring flight safety. Exceptions lay with the overseas participants. A particular case involved a situation where non-national technical experts managed the flight operations function and it appears that the owners had effectively contracted safety outcomes to these managers. Overall, the data show a marked difference between domestic and overseas airlines in regard to involvement of top management in the process of safety management. With the domestic airlines, top management appears to take a more 'hands-on' approach to its involvement with safety with the chief executive commonly chairing a safety committee. This is markedly less common in the overseas airlines.

It is interesting to speculate whether this difference between domestic and overseas airlines is culturally based or is the outcome of differences in company law, aviation safety regulation, or other 'safety drivers' such as insurance, liability law or perceptions of market discipline.

All airlines have distributed a Safety Policy Statement signed by the top executive.

Q 1.3, Q 1.4, Q 1.5 and Q 1.6 investigated the structure and functions of the airlines' safety departments. Most respondents have an independent corporate safety department. There are differences in the reporting levels of the safety department with only 73% of respondents showing a reporting level direct to the chief executive or the Board. Some writers propose that a direct reporting line to top management is important in situations where the safety department believes that line management is giving undue emphasis to 'production' and insufficient attention to 'protection'. In the interviews, one safety manager described this as a 'one shot solution'.

The overseas airlines were more likely to have a former or current line-pilot[19] as head of the safety department. The interview data shows that some heads of the safety department have no experience as an airline pilot. Whether the appointment of non-pilots to this position would contribute to the 'requisite variety' of skills necessary in HRO, as proposed by Weick (1987), could be a subject for further research. There appeared to be a wide variation in the numbers of dedicated staff in the safety

19 'line pilot' is a term commonly used to describe a pilot who is a crew member on company aircraft and thus 'flies the line'.

department. While this would have a relationship to the size of the airline, interpretation of the response is further complicated by the unusual structure of the safety departments of the domestic airlines. Four of the five domestic airlines participating in the study, share a common corporate safety department.

There was a marked difference between domestic and overseas airlines in the conduct of investigations. The domestic airlines are more likely to have their safety department responsible for investigations (Q 1.3). Unfortunately, the questionnaire did not provide for the international airlines to nominate the alternative investigator. It is assumed that in these cases, investigation is a function of line operations management. Experience has shown that disassociating investigation from line management (the disciplinary group) is a means of promoting trust and self-reporting of error (Reason 1997, p.197).

All respondents reported that regular meetings took place to discuss safety data and that a dedicated committee prepared safety reports for the senior executive and/or the Board.

As expected, all participants have a sophisticated process for collection of data, storage and analysis of data, and feedback of safety information. Differences exist in the types of data collected and/or used in analysis. Reports of accidents and incidents are collected by all respondents; however, hazard reports are not a common feature (64% of respondents). Confidential reporting was generally, but not universally, available. It is unusual for respondents to use information from training programs in their safety analysis.

Questions Q 1.8 and Q 2 address risk analysis and the extent to which it forms part of the SMS processes. Australia shares with New Zealand a formal standard on risk assessment (AS/NZS 4360:2004) and the process seems to be generally adopted in most high hazard industries in these countries. The existence of equivalent standards available to overseas airlines was not investigated: thus it is likely that differences in interpretation of the term 'risk analysis' limits the accurate interpretation of the data. A further limitation was a formatting fault in the original questionnaire that prevented a few respondents from answering the detail in this set of questions (see footnote to Table 4.3). Not unexpectedly, the non-response rate for this set of questions was high. However, it does appear that most airlines conduct some form of risk analysis. The formality of the process was not determined and this would be a fertile topic for further research.

Response to tracking of aircraft 'go-around'[20] rate as a measure of risk level was low at 30%. This is unexpected given the efforts made by the Flight Safety Foundation to reduce approach and landing accidents (ALAR program) and its associated emphasis on treating the go-around procedure as an acceptable means of assuring stabilised approaches.

Question Q 1.9 addressed the process of review of the SMS. The term 'review' implies that the organisation has a formal description of the structure and function of the SMS, most likely in the form of a company manual. The results show a marked difference in the provision of a manual covering the airline's SMS. While all domestic airlines reported that they have an SMS manual, it is the exception rather then the rule in overseas airlines. This could be the outcome of differences in regulatory requirements or it may indicate that the SMS is not mature, or that there is

20 A term used in the industry to describe the situation where an aircraft aborts an approach to land and 'goes around' for another approach.

no common understanding of an SMS. Eighty percent of participants reported that a review process was documented and conducted. The overseas airlines were less likely to use an external auditor for this process (4 domestic versus 1 overseas).

Question Q 1.10 addressed the conduct of audits. Given one 'no' response, it appears that internal audits are the norm in all airlines. Regulators conduct audits of all the surveyed airlines. The overseas airlines were more likely to contract external audits from IATA or from aircraft manufacturers (Boeing and/or Airbus). The overseas airlines are subject to more external audits than the domestic airlines. This is the likely outcome of the overseas group conducting more international operations than the domestic group and thus participating in more 'code share' arrangements with associated audits required by code share partners. Generally, it can be concluded that auditing plays an important function in safety management with the overseas airlines being subject to higher levels of independent audit.

Question Q 7 addressed the airlines' relationship with their safety regulator. All respondents reported that inspectors participated in their flight operations and that their relationship with the regulator was 'satisfactory'. There was only one negative response on the perceived effectiveness of the regulator.

5.4 High reliability

Only one facet of high reliability was addressed in the audit. Two questions were intended to provide an indication of 'organisational flexibility'. The questions were in the context of the extent to which the formal hierarchy deferred to 'expert teams' in situations of operational stress. The two questions also provided indication of 'trust', another characteristic of high reliability organisations (HRO). All airlines responded that management always supported pilot-initiated diversions (100%) and most accepted the necessity of 'go-arounds' due to unstabilised approaches (91%). These results support, in part, a presumption that airlines exhibit the characteristics of HRO (refer to section 1.7 for details on HRO).

5.5 Institutional resilience

Answers to many of the questions in the CAIR checklist require a qualitative approach and are the subject of the initial component of this study where interviews are analysed using qualitative software. Of the 20 items given in the CAIR checklist (attached), only the following are addressed in the audit: 'Regular Meetings', 'Non-technical Skills', 'Feedback', 'Safety Data', and 'Sampling of Vital Signs'.

'Regular Meetings', discussed in section 5.3, related to question Q 1.5. All airlines report that they hold regular meetings to discuss safety. 'Non-technical Skills' was addressed in section 5.1 with discussion on questions Q 4.1.1 and Q 4.1.2. 'Feedback' was addressed in section 5.3 with discussion on Q 1.7 – all airlines report that 'feedback' is in place.

The remaining two items, 'Safety Data' and 'Sampling of Vital signs' were addressed by question Q 2 in the survey. The objective was to investigate the types of data being collected by the airlines and to consider whether they can be interpreted as 'sampling of vital signs'. Effective sampling of vital signs includes both reactive and proactive measures of events and organisational processes (Reason 1997). The process involves the collection and analysis of suitable data to provide measures of 'safety health'. The expectation is that this information, including reference to change, would be presented

to top management. Information from the interviews indicates that only one airline had a clear and distinctive process to make periodic assessment of changes to its risk level.

Most airlines reported that they conducted periodic assessments of flight operations risk levels (78%). Nearly all reported that analysis of the collected data was presented to top management (90%). Again, nearly all participants had in place processes to track reactive measures such as number of safety incidents (90%), number of crew reports (80%), and audit results (90%). Sampling of proactive measures was less evident. While monitoring of FOQA data was common (89%)[21], tracking and reporting on other proactive indicators was not common practice. Examples include crew training (60%), crew fatigue (44%), and safety culture (70%). The questionnaire included other, less obvious, items which might be considered proactive measures. These were aircraft go-around rate (30%), flight diversion rate (56%) and a catch-all category 'other' (0%). The overseas airlines showed more interest in collecting data on 'crew fatigue'; however this may reflect their greater proportion of international routes which require extended periods of crew duty. The issue of proactive measures of company 'safety health' is addressed below in the section relating to further research.

Most airlines reported that they had a process in place to prioritise hazards or risks (90%). This is, in part, a similar process adopted in Tripod-Delta[22] where 'failure types' are ranked by their level of concern and then prioritised for remedial action.

5.6 Benchmarking

Questions Q 6 and Q 1.10 (in part) addressed the extent to which airlines engage in a formal process of benchmarking their safety processes, or are subject to external audits. It has been proposed that external audits can be surrogate processes for benchmarking and that both contribute to organisational learning.

Generally, benchmarking has not been adopted by the airlines (30% 'yes' response). The 'yes' responses came only from the domestic airlines. All except one respondent indicated that representatives attended international safety conferences. Little use was made of external consultants to improve safety (30%) with more interest shown by the overseas airlines. Response to questions on audits by external agencies showed that the overseas airlines are significantly more proactive in seeking input from outsiders.

21 Given the demonstrated effectiveness of FOQA it is disappointing that this result was not 100%.

22 Tripod-Delta is a safety management process developed for the oil and gas industry. The process identifies eleven 'general failure types' or GFT. Checklists are use to record the numbers of concerns expressed by field staff on each GFT. The outcome is a prioritised list of GFTs which management is expected to remedy (Reason 1997).

6 LIMITATIONS OF THE STUDY

The necessity for economy of effort demanded that this study concentrate on one facet of the myriad contributions to the safety of commercial air transport. The objective here is to address what happens within an airline. This is further limited to a study of the flight operations divisions within participating airlines, in particular the organisational and management functions within those divisions.

A difficulty faced by aviation safety researchers is the extremely low numbers of aircraft accidents. This makes it impossible to compare safety performance, with any degree of certainty, at the level of individual airlines (FAA 1997). As an alternative to accidents, a possible indicator of comparative risk levels is safety incidents or 'near misses'. During interviews with managers in the participating airlines, it was apparent that all major airlines have safety incidents, some quite serious. However, the safety defences in place, and perhaps even chance, mean that accidents remain extremely rare events. While most countries have enacted legislation requiring airlines to report both accidents and incidents, incident data is commonly not available to the public.[23] A further limitation in the use of incident data for comparative studies is the lack of certainty that all incidents are consistently categorised and reported. The outcome is that it is not practicable to make comparisons between individual airlines in regard to their intrinsic level of safety in terms of numbers of accidents and incidents.

The absence of suitable accident and incident data means that information on organisational arrangements cannot be meaningfully related to safety outcomes using quantitative methodology. Thus, study of the differences in organisational arrangements was not amenable to analysis for correlation with safety outcomes. This limited the scope of the research. However, if one accepts that the existing low accident rate for the major airlines represents acceptable levels of risk, then identified common features in organisational arrangements are useful in describing a positive contribution to achieved safety levels. In turn, this might provide a normative standard for operators in other parts of the world where national or regional accident rates are higher or, alternatively, for other less safe modes of transport.

Confidentiality is an issue influencing the successful interface between researchers and airlines. While airlines do not generally compete on the basis of safety (Rose 1992), their reputation is important, if not critical, to ongoing customer support and financial success (Rogerson 1983). Furthermore, the news media commonly over-report items on aviation safety (Barnett 1990). If this report referred to an airline by name, which the media inferred as criticism of safety standards, the result might be unnecessary publicity and public concern, which, in turn, could affect the airline's reputation and financial performance. For these reasons, none of the airlines participating in this study is identified. The issue of confidentiality, however, did not affect the level of cooperation extended by each of the participating airlines.

A further limitation was that of communication with participants and other constraints imposed by differences in language and culture. A major difficulty encountered in setting up the study was in making contact with critical decision makers who could agree to participate. As anticipated, this was more difficult with the overseas airlines than it was with the local airlines. From a sample of thirteen overseas airlines, seven agreed to participate.

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23 For example, in regard to incidents, the ATSB provides information on aircraft type and other details of the event but declines to name the aircraft operator and crew.

A limitation of the design of the study became apparent during visits to the airlines. Whereas each of the overseas airlines was an independent entity, four of the five domestic airlines shared part of their arrangements for safety oversight. In one case, a domestic airline was supplied with crew trained by the parent airline. This limits, to some extent, the validity of comparison between domestic and overseas airlines.

Care must be taken with interpretation of words. Some of the terms used in this report have specific meaning. 'Hazard' is used in the sense defined in the Standard AUS/NZS 4360:2004, 'a source of potential harm'. 'Risk' is used in the sense of the chance of an adverse event combined with the expected adverse consequences. 'Safety' is used in the sense of acceptable risk; however, it is sometimes used as a noun such as a 'safety department'. 'Flight safety' is used in terms of the acceptable risk of an aircraft accident. 'Flight Operations' and 'Flight Operations Department' are used to describe that part of an airline which is concerned with management of the flight crew, the policies and procedures associated with the operation of the airline's aircraft, and management of the flight safety department. 'Flight Safety Department' is the department charged with implementations of the airline's safety management system (SMS). 'Aircraft accident' is an event that causes death or injury to passengers or crew onboard an aircraft or which causes major damage to an aircraft. 'Aircraft incident is an event where injury or damage is less than that defined for an 'accident' or an event where safety was threatened but there was no resulting damage or injury.[24]

24 Government legislation commonly defines the terms 'accident' and 'incident' in considerable detail; however, the simpler meaning will be used in this paper.

7 FURTHER RESEARCH

The study has identified a number of topics that would benefit from further research.

The questions provided for the self-audit covered only a limited selection of proactive and reactive measures that could be used to track an airline's 'safety health'. It seems likely that additional measures could be identified which provide rich sources of information and are practical to implement and apply. Armed with such information, airlines could identify and prioritise safety-related items (general failure types) in need of improvement, perhaps using processes similar to those in Tripod-Delta or MESH. The apparent success of Tripod-Delta and MESH in other industries and other divisions of airlines, suggest that similar processes can be developed for use by flight operations divisions. It is interesting to speculate why researchers have not yet accepted this challenge.

Somewhat associated with the previous suggestion is a recommendation that the CAIR checklist be further developed and promoted so that it can provide a more useful tool for airlines to monitor their 'safety health'. Interest shown by the health care industry in the use of CAIR suggests that it has more value than has been acknowledged to date by the airlines. The other part of our research, although still incomplete at this date, indicates that the value of CAIR might be improved by including items that were perhaps beyond the reach of its conceptual development but are safety issues that must be addressed by flight operations managers. As an example, while the checklist addresses 'non-technical skills', it does not address 'technical skills'. This is an area of fundamental importance to flight safety.

A final area suitable for further research is the development of a clearer understanding of the propensity of flight crew to self-reporting on human error with a view to designing processes that facilitate higher reporting levels.

8 CONCLUDING COMMENTS

The report presents the findings of an audit of the organisational arrangements existing in the flight operations divisions of eleven major airlines based in South East Asia and Australasia. The audit contributes to a wider study on aviation safety. The audit adopted as its framework the investigation of issues associated with human factors, culture, safety management systems, high reliability, organisational resilience, and benchmarking. It is argued that these factors are subject to influence by flight operations managers and that they have an impact on airlines' safety outcomes. The objective was to obtain information on 'the way things are done' in the flight operations departments of the participating airlines.

Results from the audit provide guidance on the norm that can be accepted for organisational arrangements and management processes of airlines that demonstrate successful aviation safety outcomes. At the same time, the research shows areas where further development may be possible.

An item worthy of further attention is improvement in the demonstrated rate of self-reporting of errors by flight crews. Only 73% of participants reported that pilots regularly report on their mistakes and errors. Although there are complex issues of national culture, organisational culture, and trust, the potential benefits appear to justify the effort (O'Leary 2002). An associated issue is the separation of responsibility for investigation of accidents and incidents from line management to the safety department. Included with this organisational arrangement is the need to establish appropriate levels of confidentiality. The expected outcome is improved rates of self-reporting of error.

The data show that improvement might be possible in the selection of proactive indicators of the current level of organisational risk. The work done on programs such as Tripod-Delta and MESH might provide guidance. As an example, it seems unusual that monitoring of training is reported as receiving little attention in safety analysis. Other measures could involve events such as missed approaches, diversions, monitoring of fatigue levels, etc.

Regulators might take notice of the situation in regard to use of recorded flight data to improve the precision of flight paths and other flight parameters. Currently, the fleet-wide installation of quick access recorders and analysis of the data do not appear to be universally adopted. Information from the interviews shows that FOQA programs are beneficial in improving the accuracy of required flight parameters especially in the critical phase of flight of 'approach to land'.

In a minority of cases, there are differences in the responses between Australian airlines and their overseas counterparts. One such difference is the degree of involvement of top management and the formality of the arrangements for the SMS in place. Another difference was the extent of the use of external agencies to conduct audits and benchmarking: a process which should contribute to organisational learning.

A number of recommendations are made for further research. Value is predicted in further investigation of measures suitable for assessment of 'safety health'. Another recommendation addresses further development of the CAIR checklist and its promotion to airlines as a measure of 'safety health'.

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ATTACHMENT

Checklist for Assessing Institutional Resilience against Accidents (CAIR) – Aviation Version (Reason 2001)

COMPANY CHARACTERISTIC	YES	?	NO
1. Mindful of Danger Top managers are ever mindful of the human and organisational factors that can endanger their operations.			
2. Accept Setbacks Top management accepts occasional setbacks and nasty surprises as inevitable. It anticipates that staff will make errors and train them to detect and recover from them.			
3. Commitment Top managers are genuinely committed to the aviation safety and provide adequate resources to serve this end.			
4. Regular Meetings Safety-related issues are considered at high-level meetings on a regular basis, not just after some bad event.			
5. Events Reviewed Past events are thoroughly reviewed at top-level meetings and the lessons learned are implemented as global reforms rather then local repairs.			
6. Improved Defence After some mishap, the primary aim of top management is to identify the failed system defences and improve them, rather than to divert responsibility to particular individuals.			
7. Health Checks Top management adopts a pro-active stance towards flight safety. That is it does some or all of the following: • takes steps to identify recurrent error traps and remove them; • strives to eliminate the workplace and organisation factors likely to provoke errors, • 'brainstorms' new scenarios of failure, and • conducts regular 'health checks' on the organisational processes known to contribute to mishaps.			
8. Institutional Factors Recognised Top management recognises that error-provoking institutional factors (like under-manning, inadequate equipment, inexperience, patchy training, bad human-machine interfaces, etc.) are easier to manage and correct than fleeting psychological states such as distraction, inattention and forgetfulness.			
9. Data It is understood that the effective management of safety, just like any other management processes, depends critically on the collection, analysis and dissemination of relevant information.			
10. Sampling of 'Vital Signs' Management recognises the necessity of combining reactive outcome data (i.e., near miss and incident reporting) with active process information. The latter entails far more than occasional audits. It involves the regular sampling of a variety of institutional parameters (e.g., scheduling, budgeting, rostering, procedures, defences, training and the like), identifying which 'vital sign' is most in need of attention, and then carrying out remedial action.			
11. Staff Attend Safety Meetings Meetings relating to flight safety are attended by staff from a wide variety of departments and levels.			

12. Career Boost Assignment to a safety related function (quality or risk management) is seen as a fast-track appointment, not a dead end. Such functions are accorded appropriate status and salary.			
13. Money vs. Safety It is appreciated that commercial goals and safety issues can come into conflict. Measures are in place to recognise and resolve such conflicts in an effective and transparent manner.			
14. Reporting Encouraged Policies are in place to encourage everyone to raise safety-related issues. (One of the defining characteristics of a pathological culture is that messengers are 'shot' and whistleblowers dismissed or discredited.			
15. Trust The company recognises the critical dependence of a safety management system on the trust of the workforce – particularly in regard to reporting systems. (*A safe culture – that is, an informed culture – is the product of a reporting culture that, in turn, can only arise from a just culture)*			
16. Qualified Indemnity Policies relating to near miss and incident reporting systems make clear that the organisation's stance regarding qualified indemnity against sanctions, confidentiality, and the organisational separation of the data-collecting department from those involved in disciplinary proceedings.			
17. Blame Disciplinary policies are predicated on an agreed (i.e., negotiated) distinction between acceptable and unacceptable behaviour. It is recognised by all staff that a small proportion of unsafe acts are indeed reckless and warrant sanctions, but the large majority of such acts should not attract punishment. (*The key determinate of blameworthiness is not so much as the act itself – error or violation – as the nature of the behaviour in which it is embedded. Did this behaviour involve deliberate and unwarranted risk-taking, or a course of action likely to produce avoidable errors? If so, then the act would be culpable regardless of whether it was an error or a violation.)*			
18. Non-technical Skills Line management encourages their staff to acquire the mental (or non-technical) as well as the technical skills necessary to achieve safe and effective performance. Mental skills include anticipating possible errors and rehearsing the appropriate recoveries. Such mental preparation at both the individual and organisational level is one of the hallmarks of high-reliability systems, and goes beyond routine simulator checks.			
19. Feedback The institution has in place rapid, useful and intelligible feedback channels to communicate the lessons learned from both the reactive and proactive safety information systems. Throughout, the emphasis is upon generalisation these lessons to the system at large.			
20. Acknowledgement of Error The institution has the will and the resources to acknowledge its errors, to apologise for them, and to reassure the victims that the lessons learned from such mishaps will help to prevent their recurrence.			

SCORE : YES = This is definitely the case in this company **score 1**
? = Don't know, Maybe or Could be partially true **score 0.5**
NO = This is definitely NOT the case in this company **score 0**

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INTERPRETING THE SCORE

16 – 20	So healthy as to be barely credible!
11 – 15	You're in good shape, but don't forget to be uneasy.
6 – 10	Not at all bad, but there is still a long way to go.
1 – 5	The organisation is very vulnerable
0	Jurassic Park

CAUTION

High scores on this checklist provide no guarantee of immunity from flight safety mishaps.

Even the 'healthiest' organisations can still have bad events. But a moderate to good score (8 – 15) suggests that you are still striving to achieve a high degree of flight safety while still meeting your other production objectives. The price of flight safety is chronic unease: complacency is the worst enemy.

There are no final victories in the struggle for safety!!!!!