Cranfield University

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# A Critical Analysis of Airline Safety Management with reference to Pilots and Aviation Authority Officers

Department of Air Transport

PhD thesis

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COLLEGE OF AERONAUTICS
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PhD THESIS

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# A Critical Analysis of Airline Safety Management with Reference to Pilots and Aviation Authority Officers

**Supervisors:**
**Mr. A. Frank Taylor**
**Dr. Farriba Alamdari**

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**The Thesis is Submitted for the Degree of Doctor of Philosophy**

**Dedication:**

To my father,
who directed me to the field of aviation,
but who couldn't wait to see me completing this study.

## Abstract

When we consider regional differences in air safety, a call for regional solutions is needed. This research probes the current situation in Taiwan and part of Asia from a regional perspective, aiming to better understand safety management in this region. Data was drawn from an extensive survey involving both airline pilots and aviation authority officers. The research investigated respondents' perceptions in airline safety management, and examined at their opinions about the role of aviation regulatory authorities and language disadvantages when exchanging safety information.

The results demonstrated that there were key differences between the Captains and the First Officers surveyed in many aspects of airline safety management. The First Officers were more eager to have a blame-free and information-shared culture in current bureaucratic systems than were the Captains. Most pilots expected airline top management and aviation regulatory authorities to take more information responsibility for circulating safety related messages and information.

It is believed that a confidential incident reporting system is one of the most appropriate tools for improving safety. It would be sensitive enough to provide early identification and warning for rooting out underlying causal factors, and allow constant tracking of hazards and evaluation of risks they involve. Hence, the second part of the thesis discusses the feasibility of establishing a national-level confidential incident reporting system in Taiwan from the viewpoints of the airline pilots and the air traffic controllers.

The survey showed that there was great expectation for the introduction of a national-level confidential reporting system. However, there was need to undertake a high profile promotional period within the aviation community, followed by a two-year trial period. This would help to motivate potential reporters, eliminate their fear of punitive action, and enable consensus and support to be sought from the airlines. Initially, it is advised to begin with the participant of flight crew and air traffic controllers only. At the end of the trial period, an evaluation of the system achievements was recommended. After two years of successful operation the system might be extended to include maintenance personnel, cabin crews and other relevant parties.

## Acknowledgements

This study started as a journey into academia; the flight plan was for my doctoral thesis. Even before take-off, it became clear that this would not be a routine flight along well-travelled routes but more likely pioneering flight without resource to familiar maps and navigational aids.

One could not undertake such a solo flight without careful preparation and assistance. I am particularly grateful to all the flightcrew who have shared their expertise and experience.

First, I would like to thank my supervisors for their supervision: Mr. A. Frank Taylor, for his advice and support, and particularly for the provision of his informative collection of accident investigation reports; Dr. Fariba Alamadri for her encouragement and assistance; and Mr. Bob Golding for his support and kindness especially when I just came to England.

A research of this kind could not be possible without the co-operation and advice of the many organisations and individuals. These include:

Capt. M. J. Yin, Flight Safety Foundation, Taiwan; Capt. Kevin Greene, British Airways; Mr. Steven R. Lund, Douglus Aircraft Co.; Mr. Fons Schaefers, Fokker Aircraft B.V.; Mr. Paul Hayes, Airclaims; Capt. Paul Wilson, CHIRP, UK; Mr. Vincent J. Mellone, ASRS, USA; Mr. Jim Harris, TSB, Canada; Mr. George F. Nadal, BASI, Australia. I am also grateful to the airline managers who co-operated with this study by distributing questionnaires and all the pilots, officers, and air traffic controllers who participated in this study.

My sincere appreciation goes to Mr. C. T. Wan, President, China Aviation Development Foundation, for his encouragement and research financial support.

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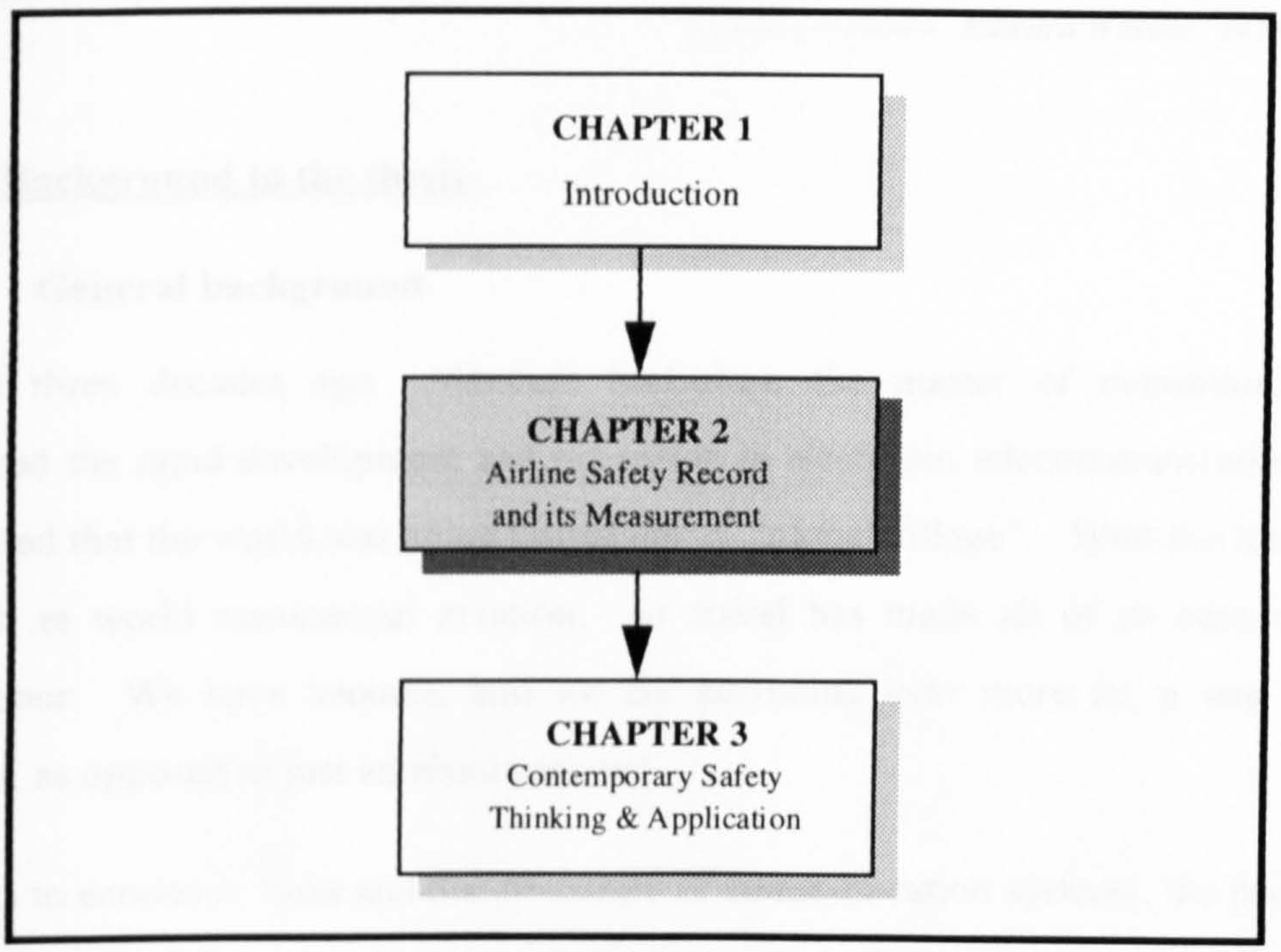
## List of Abbreviation

| | |
|---|---|
| **AAIB** | Air Accidents Investigation Branch (UK) |
| **AAIC** | Air Accident Investigation Committee (Japan) |
| **ADREP** | Accident, Incident Reporting System (ICAO) |
| **AOA** | Angle of attack |
| **ASRS** | Aviation Safety Reporting System (USA) |
| **ATC** | Air Traffic Control |
| **BASI** | Bureau of Air Safety Investigation (Australia) |
| **CAIR** | Confidential Aviation Incident Reporting Program (Australia) |
| **CHIRP** | Confidential Human Factors Incident Reporting System (UK) |
| **CIS** | Commonwealth of Independent States |
| **CRM** | Crew Resource Management |
| **EDP** | Error Detection Programme |
| **ERA** | European Regional Association |
| **EU** | European Union |
| **EUCARE** | European Confidential Aviation Safety Reporting Network (Germany) |
| **FAA** | Federal Aviation Administration (USA) |
| **FCOM** | Flight Crew Operating Manual |
| **FDR** | Flight Data Recorder |
| **FSF** | Flight Safety Foundation |
| **GPWS** | Ground-Proximity Warning System |
| **IACA** | International Air Carrier Association |
| **IACA** | International Air Carrier Association |
| **IATA** | International Air Transport Association |
| **ICAO** | International Civil Aviation Organization |
| **ILS** | Instrument Landing System |
| **ISASI** | International Society of Air Safety Investigation |
| **LOFT** | Line Operaton Flight Training |
| **MDA** | Minimum Descent Altitude |
| **MOR** | Mandatory Occurrance Reporting (UK) |
| **MOTC** | Minister of Transportation and Communication (Taiwan) |
| **MSA** | Minimum Safety Attitude |
| **NASA** | National Aviation and Space Administration (USA) |
| **NTSB** | National Transportation Safety Board (USA) |
| **OAA** | Oriental Airlines Association |
| **OSHA** | Occupational Safety and Health Act (USA) |
| **SECURITUS** | The Confidential transportation Safety Reporting Program (Canada) |
| **SOP** | Standard Operating Procedure |
| **TCAS** | Traffic Collision Avoidance System |
| **THERP** | Technique for Human Error Rate Prediction |
| **TSB** | Transportation Safety Board (Canada) |
| **VME** | Visual Meteorological Condition |

# PART I

## A General Background and Theoretical Framework




**As early as the first powered flight was made, safety has been the major concern. The Wright Brothers had their first powered airplane built in Dayton, Ohio, but made that famous first flight at Kitty Hawk, North Carolina over 500 miles away. Kitty Hawk was chosen because it was a stretch of sandy land, safe enough for test flight. As Wilbur stated in a letter to his father, "I do not intend to take dangerous chances, both because I have no wish to get hurt and because a fall would stop my experimenting."**

**As we near the end of the 20th century, the issue of safety remains crucial in meeting public desire for risk-free travel.**

# CHAPTER 1

# INTRODUCTION

" The progress of technology is not a natural process, like the growth of a tree. It is not automatic. Air transport makes progress only because man or a group of men does something."

------------------- *Edward Warner, 1958*

## 1.1 Background to the thesis

### 1.1.1 General background

About three decades ago Marshall McLuhan, the master of communications, observed the rapid development and expansion in electronic telecommunications and predicted that the world was being turned into a "global village". With the increased growth in world commercial aviation, air travel has made all of us each other's neighbour. We have become, and we are becoming ever more so, a real global village, as opposed to just an electronic one.

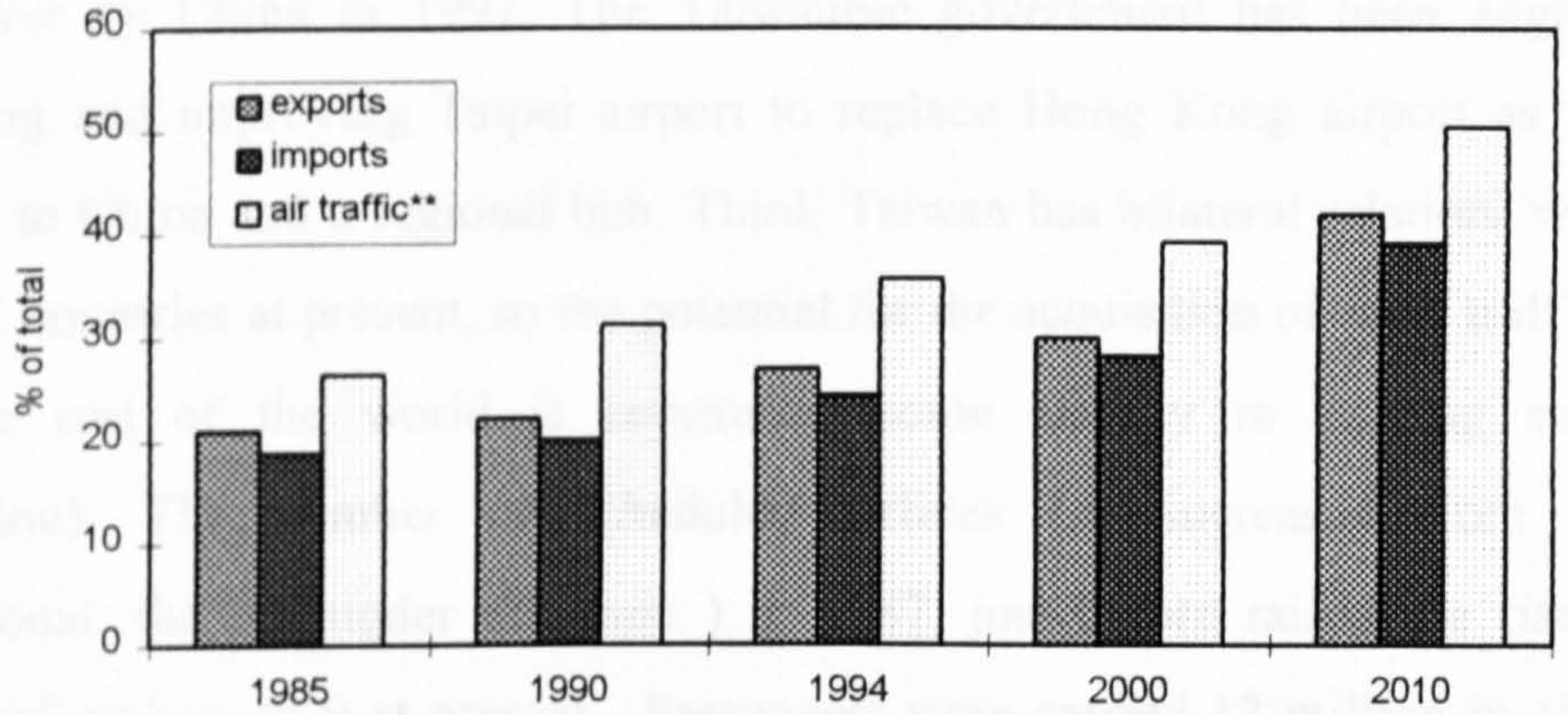
Thanks to economic links and the efficiency of communication systems, the people of this village have become more interdependent than before. Commercial aviation is experiencing rapid growth and, this looks set to continue into the next century. The airline industry is becoming more energised and more competitive, for more people are flying, more airlines are eager to meet the demands of sophisticated customers, and more modern planes are being built to meet the multifunctional needs of the commercial aviation business. In other words, we have complicated passengers, complicated planes, and a complicated aviation business. The question is, do we have better airline safety to meet the more complex demands of air travel?

### 1.1.2 Background to the study area

Throughout the 1980s and up until present, driven by the rapid economic growth of the Asia Pacific[1] region, people in Asia Pacific Rim countries, such as Japan, South

[1] In ICAO classification, Asia Pacific region is a huge area stretching from Afghanistan in the North-West to Tahiti in the South-East, and from the Indian Ocean in the South-West, to the North Pacific Ocean in the

Korea, Taiwan[2], Hong Kong, Singapore, Malaysia, Indonesia, and Thailand, are experiencing tremendous air traffic growth (see Figure 1.1). Gross National Production in these countries is rising and thus more and more people have disposable income available for travel. The relaxation of travel restrictions in Taiwan and Korea is another significant factor. Passengers are flying on business, on vacation, for studying, and for visiting relatives. With long term stability in politics, accompanied by the sustained economic growth, and with half of the world's population, Asia has become a potentially huge market in the field of air transport business over the next twenty years.




Source: WTO & ATAG
*includes Australia & New Zealand
**international scheduled passenger traffic

**Figure 1.1 Asia Rising:** Asia's* share in world trade and air traffic (includes forecasting)

According to 1995 International Civil Aviation Organisation (ICAO) annual civil aviation report, more than 1,203 million passengers were carried by the scheduled airlines of ICAO Contracting States, equivalent to approximately 25% of the world's population. By the year 2000, it is expected that 1,800 million passengers will travel by air, equivalent to about 30% of the world's population at that time. Demand for air transport in Asia Pacific region is growing faster than in any other world region. It grew at an average of 10.3% per annum between 1985 and 1993. It will grow by an

North-East. The term Asia Pacific countries includes all the countries in this region with the exception of Australasia.

2 Though strictly a geographical term, The name Taiwan is used by most people in the world when referring to the country called the Republic of China. For consistency, the author adopts the name Taiwan in this study.

average of 8.6% per annum between 1993 and 2000 and 7.1% per annum between 2000 and 2010. The region's share of world-wide scheduled passenger traffic was 26.4% in 1985. It increased to 35.5% in 1993. It will reach 41.2% by 2000 and 50.5% by 2010 (ATAG, 1995)

Demand for air transport in Taiwan is growing as fast as that in other Asia Pacific countries. Long-term prospects are enhanced by the following positive factors. First, the expectation of direct air and/or sea links with China will be fulfilled as relations with China eventually normalise. It is expected that mainland China will present major new market opportunities. Second, considering that Hong Kong is going to be taken over by China in 1997, The Taiwanese government has been engaging in expanding and improving Taipei airport to replace Hong Kong airport as a future gateway to China and a regional hub. Third, Taiwan has bilateral relations with only about 31 countries at present, so the potential for the acquisition of new traffic rights with the rest of the world is enormous (some already in varying stages of negotiation). The number of scheduled airlines has increased from 4 (one international, the remainder domestic ) in 1987, just before raised the rise of the "open sky" policy, to 9 at present. Passengers were carried 12 million in 1987 and 32.6 million in 1994 (Civil Aeronautical Administration-Taiwan, 1994).

The rapid air transport growth in Asia Pacific countries has resulted in some changes: First, the reduction of profitability. Due to the growth in capacity outstripping demand and the influence of world recession, the profits of airlines continues to fall. The high profits achieved in the late 1980s seem impossible to be achieved again. According to Oriental Airlines Association (OAA) statistics, though the OAA airlines' growth in capacity continues to exceed the rise in traffic, profit levels and load factors are back to levels experienced in the early 1980s. Second, modernisation of aircraft. Capacity of aircraft continue to increase and flight decks become more automated. Third, change in customers' demands. Passenger expectations and demands increase more than ever. Their demands have shifted from hard[3] values to soft and brand values (Simons, 1994). For examples, they ask for competitive pricing but qualified service, they desire more flights and more routes, they expect on-time takeoff and landing, and they cannot stand any delay. In 1995, there were several instances of passengers refusing to step off the aircraft due to the schedule delay in Asia (see Table 1.1).

**Table 1.1 : Events Involving Passengers Occupying Aircraft Due to Flight Delay**

| Date | Operator | Flight No. | Contributing factor | Settlement |
|---|---|---|---|---|
| 1 Jan. 1995 | Cathay Airlines | CX 511 | Collision of cabin door and bridge | Arrange another flight |
| 21 Feb. 1995 | Vietnam | | Nose gear malfunction | US$ 200 compensation fee for each passenger |
| 23 Apr. 1995 | Cathay Airlines | CX 434 | Mechanical malfunction | Arrange accommodation |
| 7 May 1995 | Eva Airways | BR 061 | Undercarriage abnormal | Arrange accommodation |
| 26 Aug. 1995 | China Airlines | CI 008 | Engine malfunction | One-way ticket from Taipei to LA for each passenger |
| 26 Aug. 1995 | Northwest Airlines | NW 012 | Engine malfunction | Arrange transfer flight or accommodation |
| 19 Oct. 1995 | Canada Airlines | CP 017 | Undercarriage malfunction | US$ 200 compensation fee and a return ticket from Vancouver to Taipei |
| 25 Dec. 1995 | Indonesian Airlines | GA 980 | Flight dispatch problem | US$ 200 compensation fee for each passenger |
| 14 Feb. 1996 | Cathay Airlines | CX 460 | No. 4 engine malfunction | Formal apology letter and a box of chocolate for each passenger |

Source: Compiled from Central Daily News, United Daily News, and China Weekly Data from Jan. 1995 to March 1996

The one thing that does not change is that passengers cannot accept the occurrence of aircraft accidents as shown in Figure 1.2. Because of the threat of competition in the market and the demands of passengers, airlines have to strive to be the very best they can be both in terms of safety and service.

[3] Hard values are the fundamental physical requirements of running an airline, such as aircraft, schedules, infrastructure, and management. Soft values are the tactile areas of flying aircraft, such as cabin staff, food, interior design etc. Brand values are the often deeply rooted characteristics or image of an airline.

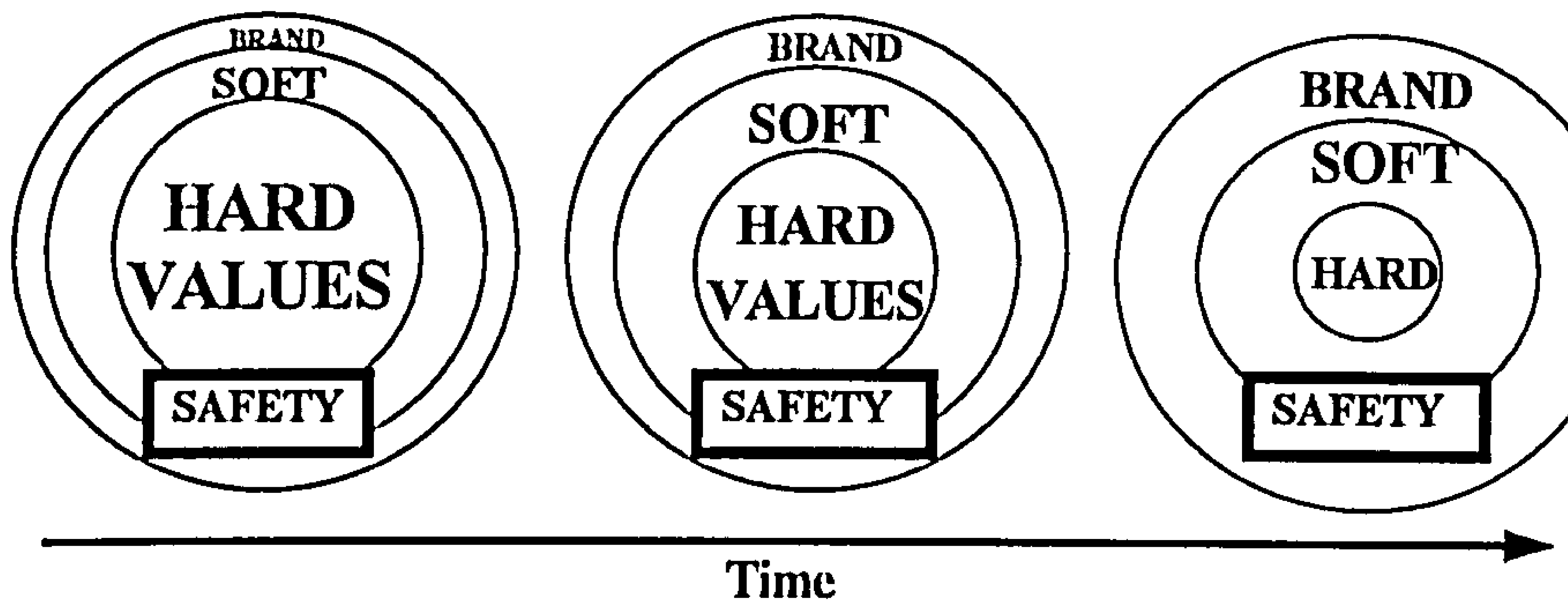



**Figure 1. 2 Safety is a Paramount Aviation Value**
Source: revised from Simons, 1994

It is undeniable that safety has become the trademark of the airline industry. In 1994, the US Federal Aviation Administration (FAA) conducted a safety audit program for 30 countries (out of 183 ICAO Contracting States) in the world and consequently banned nine Latin American and African airlines from entering the USA. Of these four Latin American airlines were permitted to enter again conditionally after a recheck by FAA. A country's rating is based on an evaluation of the laws that enable the aviation regulatory authorities to adopt regulations in order to meet ICAO standards, current regulations, procedures to carry out regulatory requirements, air carrier certification and inspection programmes and available organisational and personnel resources. During the same year, in order to ensure aviation safety, the International Air Carrier Association (IACA) banned European Union (EU) nations from renting ageing aircraft from less safety-conscious countries for charter flights. Moreover, a "Safety Oversight Programme" was designed in 1993 by ICAO to help its member states to monitor air transport safety and ensure compliance with ICAO safety standards. The primary objective of the programme is to identify deficiencies and offer advice and assistance until progress is confirmed.

The commercial aviation business is an international business. In Asia-Pacific, many new entry airlines are about to initiate or have just initiated flying international routes. From an international viewpoint, any aircraft accident involving one airline in one area will affect the image of many other airlines. Therefore, methods to establish high standards of safety and a qualified service management system will be addressed this study.

### 1.1.3 Reasons for choosing the study area

Most studies of airline safety have been implemented in, or developed in western countries. They have focused on airlines in these countries and chosen western pilots and/or accidents/incidents as their research subjects. Although the findings of these studies have benefited some countries, they may not accurately reflect the situation in other regions of the world.

World-wide airline safety rates have not improved for twenty years (Oster, 1992, Weener, 1993; Hayes, 1994). Facing the challenge of improving safety rates, research on accident prevention strategies (Boeing, 1994) has shown that solutions deriving from previous western studies may not be practical in regions with different cultures. In order to be successful in lowering the accident rates, regional programmes that reflect localised characteristics and differences should be designed. Also with regard to regional differences, more precise methods of analysing of regional studies are needed.

## 1.2 <u>Objectives of the thesis</u>

The overall purpose of this research was to investigate regional airline safety management. In order to achieve the purpose, the study was carried out in three parts:

Part 1:
- To probe into contemporary issues in aviation safety
- To analyse accident / incident contributing factors in the Asia-Pacific region and Taiwan

Part 2:
- To understand pilots' viewpoints regarding airline safety management
- To survey and investigate the factors that pilots believe will influence airline safety management

Part 3:
- To review current confidential incident reporting systems in the UK, USA, Canada, Australia, Germany, and New Zealand

- To administer and analyse a feasibility study for implementing a national confidential incident reporting system in Taiwan.

## 1.3 Data sources and their limitations

### 1.3.1 Aspects on the data sources

The following table shows the data sources of accident reports and the subjects of the survey.

**Table 1.2 Sources of Accident Reports and Subjects of the Survey**

| | Data Sources | Reports / Subjects |
|---|---|---|
| Part 1 | International accidents: Flight International, Air Safety Week, UK CAA WAAS, ICAO ADREP* | Summary, Reviews |
| | Asia accidents: ICAO circular, AAIC Japan, CAA Taiwan, Boeing, MCD, Fokker Airbus, British Aerospace. | Accident investigation reports[4] (official and unofficial) |
| | Taiwan accidents / incidents: CAA Taiwan | Accident / incident investigation reports |
| Part 2 | Questionnaires:<br>Asia:<br>12 international airlines<br>8 civil aviation authorities<br>Taiwan:<br>6 scheduled airlines | <br><br>Management Captains<br>CAA staff<br><br>Captains / First Officers |
| | Interview: Taiwanese airlines | Captains / First Officers |
| Part 3 | Questionnaires: 5 Taiwanese airlines | Captains / First Officers |
| | Interviews: Airlines, CAA, | Airline operation managers, CAA officials, |

* All these abbreviation, please refer to list of abbreviation.

Details of data collection together with some main difficulties encountered in each part are as follows:

**Part 1 :**

[4]The accident investigation reports which apply to this research are mostly Asian aircraft accident cases. The purpose is to do the research and promote aviation safety only. In no case, it is intended to imply bias or blame.

*Data collection*: The empirical findings for the first part are based on three different information sources i.e. 1) published material, 2) unpublished reports, and 3) compilation data from the above sources.

Published material refers to ICAO documents, accident investigation reports of each country, articles and books. Unpublished reports were gained from aircraft manufacturers. These accident investigation reports were obtained by special requests to a number of companies, such as British Aerospace, Boeing, McDonnell Douglas, Airbus, and Fokker. Some other data were created through compilation of the airline industry journals, such as Flight International, Interavia, Aviation Week and Space Technology, Air Safety Week, UK CAA's WAAS, and ICAO ADREP.

*Difficulties in data gathering:* This part of the research process has encountered two problems. The first was related to the general availability of information, and the second was associated with language.

Most Asian civil aviation authorities and airlines have been very reluctant to offer any information, not only because they tend to be conservative and self-protective, but also because they might have still not accepted that academic research is advantageous for their safety. Japan, Hong Kong and Singapore are the three exceptions, for their airlines and civil aviation authorities provided the author with better responses to the research requests. Another possible reason might be that some Asian civil aviation authorities and airlines have not built up detailed data bases of their own and thus have been used to adopting western research results when dealing with their safety matters.

Therefore, the practise of information sharing cannot be expected from them. In these cases, it has been necessary to rely mainly on information obtained through compilation of data from aircraft manufacturers, ICAO published papers, and airline journals.

The other inevitable, (though not insoluble) difficulty encountered was the problem of language. Some of the formal Asian accident data or reports were written in native languages. If they were to be translated into English, it would require many people, take a great deal of effort, cost a great deal of money. Consequently this option was unfeasible. The information obtainable from manufacturers and airlines, on the contrary, is informal and apt to be biased.

Information on international Asia-Pacific airline operations and safety is not as comprehensive as that for the UK, USA, Canada, or even most Western European countries. The ICAO, collects data and conducts accident and incident analyses for its member countries. As of 1993, there were 92 member nations in ICAO, representing 146 international scheduled airlines, 60 domestic scheduled airlines, and 26 charter operators.

Safety data collected by ICAO is known as the Accident, Incident Reporting (ADREP) System. A significant problem, however, is the lack of current data. The ADREP annual statistics and corresponding accident summaries appear with a lag of at least two years. This lengthy delay occurs because initial data reporting from some nations is inconsistent and often sketchy, which then requires substantial follow-up effort to obtain more reliable data. As of mid 1996, the most recent publicly available ICAO ADREP safety data covered 1993.

However, information on international airline safety is available from other aviation publications. Flight International and UK CAA WAAS (from the same source: Airclaims) provide an annual summary of fatal and nonfatal accidents for the world's airlines and includes information on date, airline, aircraft, fatalities, passengers, and a brief summary of the accident . For this analysis, information was also supplemented by reports on each accident available in other aviation publications, including Air Safety Week, Aviation Week and Space Technology and Interavia. To evaluate the accuracy of these various data sources, the information was compared with that produced by ICAO's ADREP system for the 1984-1993 period. The data from Flight International covers a slightly higher number of accidents over the period, with little year-to-year variation. Virtually all the accidents in the ICAO ADREP data appear in the Flight International series; the only noteworthy exceptions are accidents in Russia

(CIS) and China. Thus, although some reporting biases, and some differences in numbers remain, the available data allows an adequate assessment of the international aviation safety record to be made.

**Parts 2 and 3 :**

*Data collection:* Data was collected from questionnaires and interviews. In Asian countries, it took longer than anticipated to have questionnaires delivered to the subjects. A few returned questionnaires were received two months after the reminding letter was mailed. Upon asking for the reason for late reply, it was found to be caused by language problems of mail carriers' and the busy flight schedule of the pilots concerned.

In order to maximise the number of subjects questioned and gain better access to them, three field trips were made to several Taiwanese airlines headquarters and training centres in Taipei and Kaohsiung during September 1994, May 1995, and December 1995, respectively. In addition to meeting many flight operations managers, flight training managers, Captains, First Officers, and safety staff of airlines (including expatriate Captains), the research work has, of course, also been carried through by extensive writing of letters, and facsimile transmissions, as well as making telephone calls to companies, managers, and pilots, requesting different kinds of information.

*Difficulties of data gathering:* With the limited resources of Asian international airlines, the questionnaire was only distributed to the management Captains such as directors of flight operations, chief pilots, and check pilots of each airlines.

As mentioned at Section 1.3.2, the research questionnaires in Taiwan were distributed with the help of some management Captains. In some cases , they requested permission to preview the completed questionnaires before returning them back to the author. Obviously, this affects the confidentiality of the questionnaires.

In the case of the Taiwanese airline questionnaire survey, there was one airline that participated in the part 2 survey but refused to participate in the part 3 survey. The reason for this was that the conductor ( a check pilot) asked for top manager's permission to distribute the part 3 survey, but did not get any response. Unfortunately, silence is always taken to mean "no" in Chinese culture. In this situation, the conductor decided not to distribute the follow-up survey.

## 1.4 Structure of the thesis

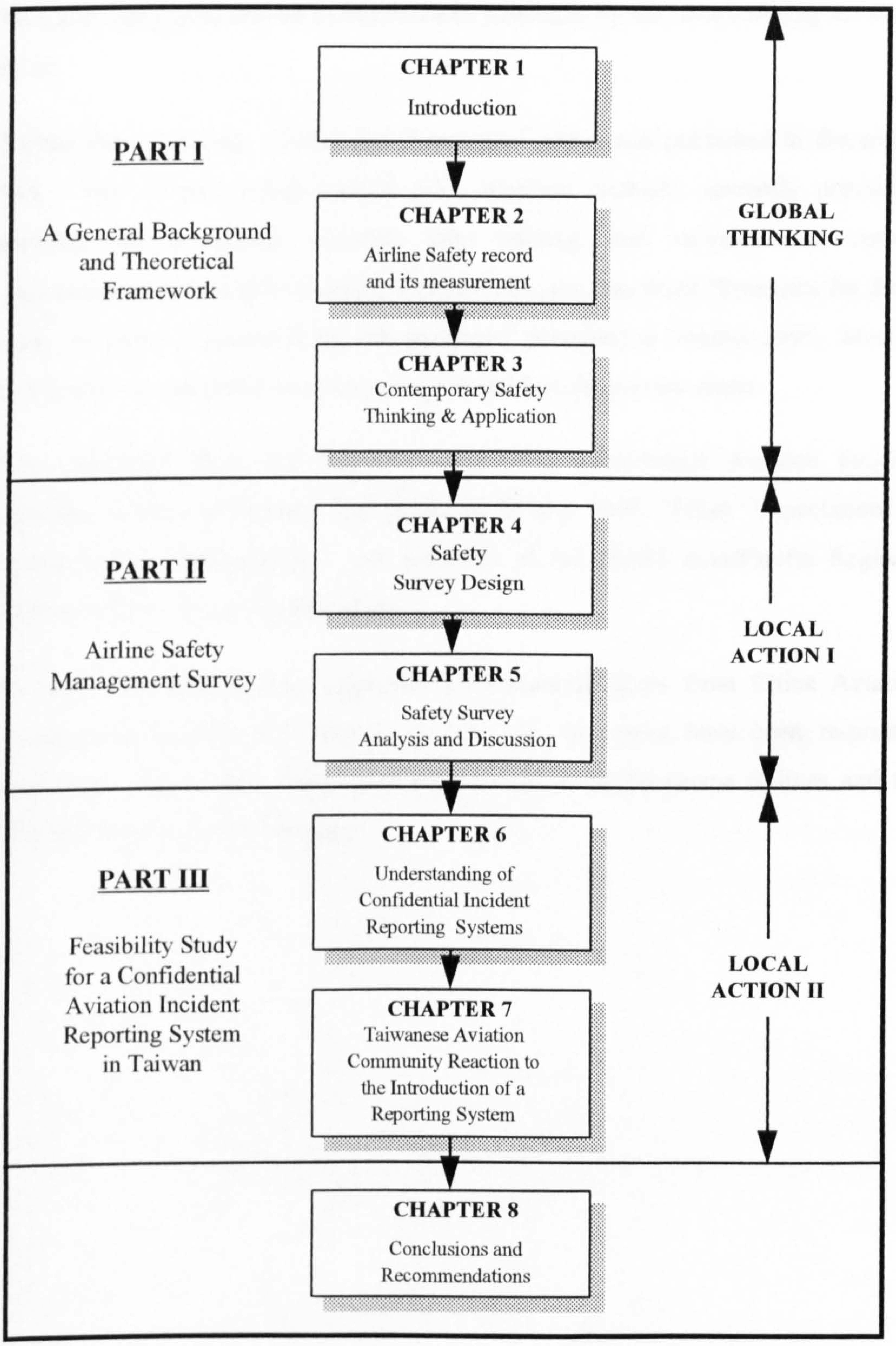
The study (see Figure 1.3) starts by providing an overview of contemporary issues in airline safety. It then undertakes an analysis of the possible contributing factors that cause accidents/incidents in the Taiwan/Asia-Pacific region. Finally, it implements a survey of airline safety to provoke thought about future options for improving safety performance, and undertakes a feasibility study for implementing a confidential incident reporting system in Taiwan.

The thesis is divided into three parts with 8 chapters. In part 1, the universal trend of aviation safety is reviewed and the regional differences are examined. Chapter 1 provides an introduction to the study. Chapter 2 examines airline safety records and their measurement, aiming to show how safety management can influence safety performance. Chapter 3 discusses contemporary safety theories and their applications, and presents a general discussion of recent aviation safety issues, such as human failures, the use of a systemic approach to analyse accident causes, incident reporting, safety culture, aircraft automation, etc.

Part 2 focuses on the survey of airline safety management to Twelve international Asian airlines and six scheduled Taiwanese airlines. Chapter 4 presents the demography and the process of the survey, while Chapter 5 deals with the results and discussion of the survey in terms of organisational structure, corporate culture, flight training, operating standard, and company resource management.

Part 3 examines the possibility of implementing a national confidential incident reporting system in Taiwan. Chapter 6 explores the existing reporting systems in use world-wide, their effectiveness and the difficulties they have encountered. Chapter 7 focuses on the feasibility study for a national confidential incident reporting system in Taiwan. It discusses the opinions that people in the field hold about establishing the system and their willingness of using an Internet-based system to report incidents. Finally, summaries and the suggestions from the empirical findings are given in Chapter 8.

# FLOWCHART OF THE RESEARCH



## 1.5 Publications during the period of this study

There are four papers related to this research published by the author during the study period.

"Airline Pilot Training: Today and Tomorrow" paper was published in December 1994. The covered topics include pilot selection methods, currently prevailing practices and limitations, *ab-initio* pilot training, and various other current programmes of airline pilot training. The second paper was titled "Prospects for Safer Skies: A Study of Airline Safety Management" published in October 1995. Most of the content was adapted from chapters 2,3,4 and 5 of the present thesis.

"The Feasibility Study for Implementation of a Confidential Aviation Incident Reporting System in Taiwan" was published in May 1996. "Pilots' Expectations of Airline Safety Management " was presented at the ISASI Asia/Pacific Regional Seminar held on 29 and 30 May 1996.

The first three papers were supported by a research grant from China Aviation Development Foundation, Taiwan, and 50, 110, 80 copies have been re-printed respectively. These have been distributed around most Taiwanese airlines and the Taiwan CAA for their references.

# CHAPTER 2

# AIRLINE SAFETY RECORD AND ITS MEASUREMENT

"If you don't know where there is a problem until an accident occurs, you are a part of that problem."

-------- *C. O. Miller*

## 2. Overview

The past is an invaluable resource because it allows us to know how to face the future. The purpose of aircraft accident investigation is, therefore, for us to prevent past disasters from happening again. The chapter compares several organisations in terms of the definitions of accidents and incidents, describes how safety records are measured, points out the differences of world-wide accident rates by regions, and analyses the contributing factors of incidents and accidents in Asia for the past ten years and in Taiwan after the open policy was implemented in 1988.

## 2.1 Aircraft accident definitions and categories

An aircraft accident usually causes a different degree of aircraft damage, casualty or injury, and property loss. Though there are several variations, the most widely used definition is the one developed by the International Civil Aviation Organisation (ICAO, Annex 13, 1994). Its definitions of aircraft accident, serious incident, and aircraft incident are listed below:

### 2.1.1 ICAO's classification

*AIRCRAFT ACCIDENT: An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which:*

*a) a person is fatally or seriously injured as a result of:*

- *being in the aircraft, or*
- *direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or*
- *direct exposure to jet blast.*

*EXCEPT when the injuries are from natural causes, self inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or*

*b) the aircraft sustains damage or structural failure which:*

- *adversely affects the structural strength, performance or flight characteristics of the aircraft and*
- *would normally require major repair or replacement of the affected component.*

*EXCEPT for engine failure or damage, when the damage is limited to the engine, its cowlings or accessories; or for damage limited to propellers, wing tips, antenna, tyres, brakes, fairings, small dents or puncture holes in the aircraft skin; or*

*c) the aircraft is missing or is completely inaccessible.*

*Note 1. For statistical uniformity only, an injury resulting in death within thirty days of the date of the accident is classified as a fatal injury by ICAO.*

*Note 2. A serious injury is one which:*

*a) requires hospitalisation for more than 48 hours, commencing within seven days from the date the injury was received; or*

*b) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); or*

*c) involves lacerations which cause severe haemorrhage, nerve, muscle or tendon damage; or*

*d) involves injury to any internal organ; or*

*e) involves second or third degree burns, or any burns affecting more than 5 percent of the body surface.*

In order to effectively prevent accidents and promote aviation safety, ICAO revised the content of annex 13 in March of 1994. It suggests its state members to define "serious incident" and to thoroughly investigate them.

"SERIOUS INCIDENT is an incident involving circumstances indicating that an accident nearly occurred" (Annex 13, P.2). Namely, the difference between accidents and serious incidents is the result. For example, at about 1050 local time on February 11, 1991, an Interflug A310 while conducting an approach to Moscow's Sheremetyevo airport runway 25L initiated a go-around after being requested to do so by Sheremetyevo tower. The go-around procedure was initiated with the No. 1 autopilot in the "command" mode at an altitude of approximately 1,500 feet. The aeroplane experienced five stalls during the next several minutes of flight. This is a serious incident.

Attachment D of ICAO Annex 13 lists 15 typical examples of incidents that are likely to be serious incidents as guidance to the definition of a serious incident.

*a) Near collisions requiring an avoidance manoeuvre to avoid a collision or an unsafe situation or when an avoidance action would have been appropriate.*

*b) Controlled flight into terrain only marginally avoided.*

*c) Aborted take-offs on a closed or engaged runway.*

*d) Take-offs from a closed or engaged runway with marginal separation from obstacle(s).*

*e) Landings or attempted landings on a closed or engaged runway.*

*f) Gross failures to achieve predicted performance during take-off or initial climb.*

*g) Fires and smoke in the passenger compartment, in cargo compartments or engine fires, even though such fires were extinguished by the use of extinguishing agents.*

*h) Events requiring the emergency use of oxygen by the flight crew.*

*i) Aircraft structural failures or engine disintegrations not classified as an accident.*

*j) Multiple malfunctions of one or more aircraft systems seriously affecting the operation of the aircraft.*

*k) Flight crew incapacitation in flight.*

*l) Fuel quantity requiring the declaration of an emergency by the pilot.*

*m) Take-off or landing incidents. Incidents such as undershooting, overrunning or running off the side of runways.*

*n) System failures, weather phenomena, operations outside the approved flight envelop or other occurrences which could have caused difficulties controlling the aircraft.*

*o) Failures of more than one system in a redundancy system mandatory for flight guidance and navigation.*

Although the 15 examples of incidents listed above are intended to define what serious incident is, they are not all encompassing and are subject to interpretation and judgement.

*INCIDENT: An occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.*

The definition of incident is adopted by many aircraft accident investigation organisations, such as the Air Accident Investigation Board (AAIB) in the UK; the National Transportation Safety Board (NTSB) in the USA; the Transportation Safety Board (TSB) in Canada; the Bureau of Air Safety Investigation (BASI) in Australia, and the Air Accident Investigating Committee (AAIC) in Japan.

### 2.1.2 Classification by Monetary Cost

United States military services uses aircraft mishap to describe either accidents or incidents. The property damage includes the official estimate of damage to non-military property and is classified in terms of dollar costs as below (USAF 1990):

*Class A Mishap. A mishap resulting in:*

*a) Total cost of $1,000,000 or more for property damage, or*
*b) A fatality, or permanent total disability, or*
*c) Destruction of, or damage beyond economical repair to, a military aircraft.*

*Class B Mishap. A mishap resulting in:*

*a) Total cost of $200,000 or more, but less than $1,000,000 for property damage, or*
*b) A permanent partial disability, or*
*c) Hospitalisation of five or more personnel.*

*Class C Mishap. A mishap resulting in:*

*a) Total damage which costs $10,000 or more, but less than $200,000.*
*b) An injury or occupational illness which results in a lost work-day case involving days away from work (i.e., 8 hours or greater).*
*c) A mishap which does not meet the criteria above, but which requires reporting.*

There are standard injury, illness, and fatality costs showing the cost standards for military and civilian injuries and occupational illness. These standards are used to account for mishap cost and analysis. For example, the loss is calculated as

$1,100,000 if a rated officer dies, and $1,300,000 if he becomes a permanent total disability. Whereas the standard costs for the death of a civilian employee is $460,000, and for his permanent total disability, $385,000. The military definition of injury (fatal, permanent total, permanent partial) follows those adopted by the US Occupational Safety and Health Act (OSHA).

Airclaims, a leading insurance company in the UK, also uses cost loss to classify, what it called, "major partial losses" from the other categories, such as, fatal accident, total loss and passenger fatalities. The definition of major partial losses is as follows:

> *An accident which so far as Airclaims has been able to ascertain, resulted in repair cost of not less than:*
> *a) $ 1,000,000 or*
> *b) 10% of the insured value of the aircraft (or in certain cases the estimated value of the aircraft).*

### 2.1.3 Accident definition of a selected Asian developing country[5]- Taiwan

To suit their own needs and situations, developing countries usually adapted the aviation rules, regulations and codes of the developed countries, especially those with aircraft manufacturers.

The following definition of aviation events in Taiwan was abstracted from the Aircraft Accident Investigation Code, Chapter 1, Articles 2 and 3.

a) Accident: The same as the definition of ICAO.
b) Incident: An aircraft occurrence with damage but no fatality. The six types of incident are:
   - *an injury or aircraft damage while engine is running;*
   - *in-flight fire without causing any damage;*
   - *engine failure or malfunction in flight;*
   - *flight control system malfunction or failure;*
   - *inability of any required flight crew member to perform normal flight duties as a result of injury or illness;*

[5] Standard World Economic Outlook Groups classify countries into three groups by their aggregate Gross Domestic Production, total exports of goods and services, and total debt outstanding. The three major groups are industrial countries, developing countries, and countries in transition. In Asia, Japan and Singapore (taking effect on Jan 1, 1996) are the only industrial countries, and the rest of them are developing countries, including Taiwan.

- *an injury or property damage of any ground crew member due to the falling of aircraft components or objects in flight.*

c) Hazard: An occurrence, other than an accident or an incident, associated with the operation of an aircraft which affects or could affect the safety of operation.

d) General event: Referring to general operational violation.

It is obvious that the ICAO definition of damage and the US military classification of damage are totally different. ICAO uses the term "accident" to refer to major damage or serious injuries, whereas the US military adopts "mishap". To the latter, "accident" is used to describe the unavoidable "Acts of God". Taiwan's definition, though similar to that of ICAO, is not the same. Further discussion will be provided later in this Chapter about the problems resulting from the organisational or geographical variations in the definition of accidents.

It is fairly simple to determine accident cost by adding all reportable damage, injury, and illness cost. Its disadvantages, as Wood (1992) argued, are that the dollar amounts need to be regularly adjusted to reflect the rate of inflation, and the figure reported is probably low in terms of the actual value.

## 2.2 The economics of safety

### 2.2.1 A tremendous price: Cost of accidents

The impact of an accident is striking; it can inflict on an airline's reputation, productivity and other commercial obligations. It is not possible to estimate the loss these effects bring forth. The consequences of any accident not only cannot be quantified but vary from case to case. What is certain is that these effects cannot be underestimated and that they have a major impact on any operation.

There are two basic categories of accident costs: insured costs and uninsured costs. Traditionally safety specialists classified as direct and indirect costs. The older concept of indirect costs may be used interchangeably as the uninsured costs, but direct costs meant actual claims paid by insurance companies, commonly compensation payments and medical expense, and overlooked the difference between insurance premiums and recovered payments. Accordingly, safety specialists abandoned the old expressions and use the more precise terms "insured" and "uninsured" costs.

Insured costs are the cost of workers' compensation insurance, usually referring to those covered by insurance companies against hull losses, property damage and personal liability. In general, the insured costs are simply the net amount of the insurance premiums.

> *On average, the net insurance premiums will be large enough to cover the money paid for medical expenses on compensatory cases and compensation to the injured employee, as required by law, plus the expenses and profits of the insurance company in connection with that insurance. (Grimaldi and Simonds, p111)*

Unlike insured costs, uninsured costs must be estimated and cannot be recovered, but they may result in the raising of premiums. Typical insured and uninsured costs of an accident include:

**Insured Costs**

| INJURIES | PROPERTY DAMAGE |
| --- | --- |
| • Compensation for lost earnings | • Fire |
| • Medical and hospital cost | • Loss and damage |
| • Awards for permanent disabilities | • Use and occupancy |
| • Rehabilitation costs | • Public & Liability |
| • Funeral charges | |
| • Pensions for dependants | |

**Uninsured Costs**

| | |
| --- | --- |
| • Insurance deductibles | • Increased operating costs on remaining equipment |
| • Lost time and overtime | • Cost of hiring and training replacements |
| • Legal fees resulting | • Loss of spares or specialised equipment |
| • Increased insurance premiums | • Loss of business and damage to reputation |
| • Cost of restoration of order | • Reaction by crews leading to disruption of schedules |
| • Fines and citations | • Loss of productivity of injured personnel |
| • Morale | • Liability claims in excess of insurance |
| • Cost of corrective action | • Cost of rental or lease of replacement equipment |
| • Loss of use of equipment | • Corporate manslaughter/criminal liability |
| • Cost of the investigation | • Overhead costs while production is stopped |
| • Unfavourable public relations | • Time spent on injured workers welfare |
| • Training replacement worker | • Decreased production of replacement |
| • Increased labour conflict | |

Source: adapted from Flight Safety Digest, Dec. 1994, p.3. and Beaty, 1995, p.215

Though tangible costs may be quantified, some intangible costs can acquire greater importance than the tangible costs. The intangible costs of accidents vary greatly from country to country, and their importance is not solely determined by economic consideration. When political consideration overrides the economic one, the monetary value is not the most critical factor. In countries where the overriding consideration is to avoid damage to the national image among the international community, the cost of an accident of the flag carriers is perceived as greater than the direct financial loss. Here is a good example. Due to the poor safety performance of Air China, China's flag carrier, most Asian businessmen would rather fly the more expensive and crowded Dragon Air to avoid risk when they are conducting their business in China. In some situations, schedule disruption following the damage of aircraft and equipment in an accident also might override the loss measured by accounting methods. In other situations, the impact of accidents on airline's passenger traffic, such as the public image and the chain effect on the loss of sale, is considered more difficult to recover than the loss in accidents. For example, the monthly Revenue Passenger Kilometres (RPKs) growth rate of China Airlines dropped dramatically for almost 25% after the accident at Nagoya, Japan, and it took approximately six months to return to normal (Airline Business 1994-95). There are two fundamental points that should be noted in relation to the cost of accidents: firstly, there are economic consequences of aviation safety; secondly, the costs and benefits of safety cannot be measured only in economic terms.

### 2.2.2 Insurance cost for safety

In 1994, some 340,000 clients from the aeronautics industry paid approximately $5 billion in premiums to insure themselves against hull, liability and business interruption risks. Of the total premium volume, 1,750 millions dollars was paid by airlines (Swiss Reinsurance, 1996). It is more than one third of the direct premium volume. Over 50% of total volume derives from 460 clients who paid in excess of $1 million per annum, and 200 of the clients are from major airlines.

Though passenger liability settlements vary from developed countries to Third World, the costs remain an equally massive portion of the underwriting risk and will continue to grow if the accident curve cannot be turned down. Nowadays, increased claims made by passengers or their dependants who seek compensation from an airline, aircraft manufacturer or another associated party, not only will result in increased aircraft insurance premiums, but in turn will result in high purchase and operating costs.

Figure 2.1 shows the world airline underwriting results from 1980 to 1994. British Aviation Insurance Group forecasts by the end of the decade $2 billion will be made to underwrite passenger liability costs. As a result, even aircraft insurers and underwriters could face $3 billion recovering losses in 10 years.

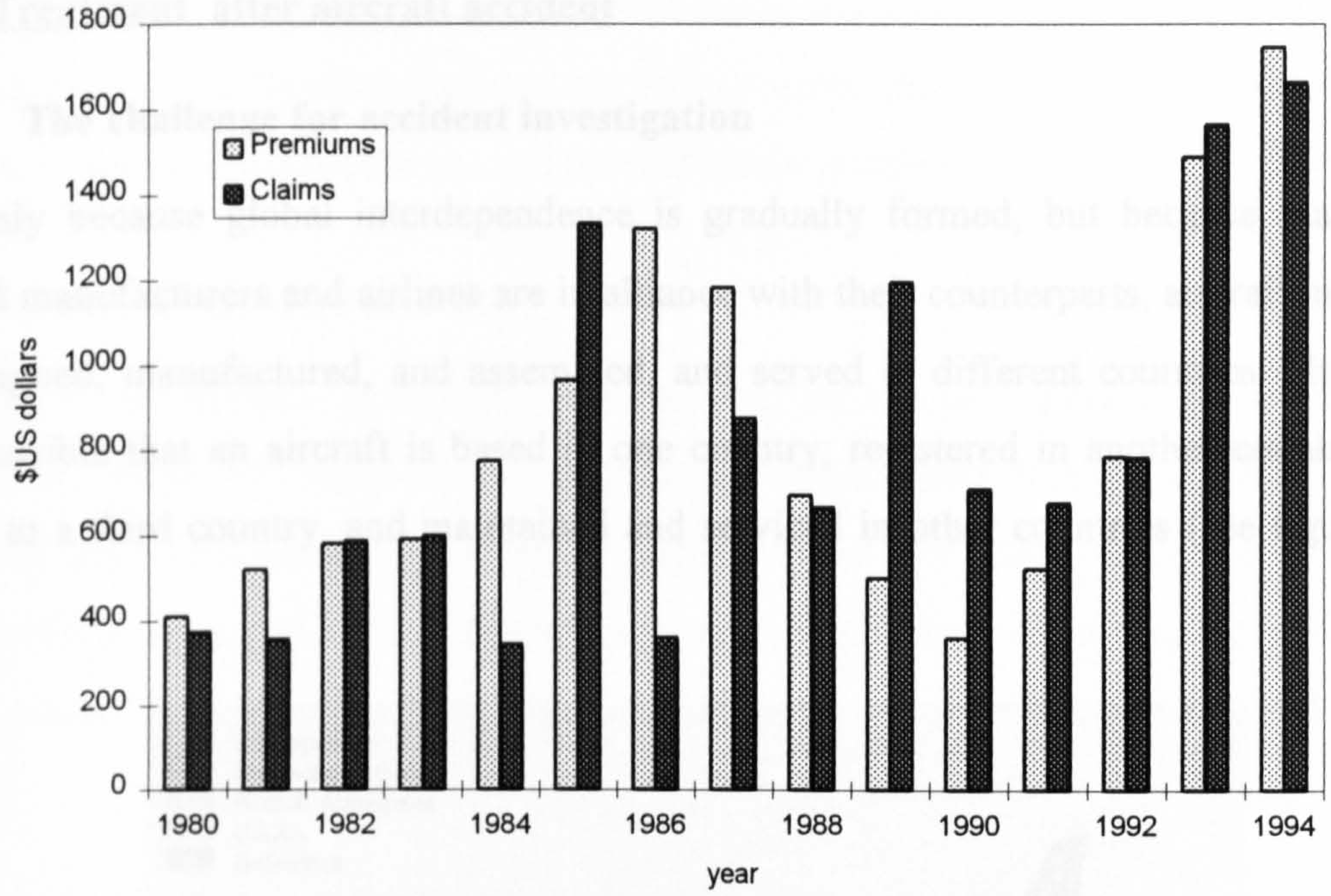



**Figure 2.1 World Airline Underwriting Results (1980-1994)**

Source: British Aviation Insurance Group & Swiss Reinsurance

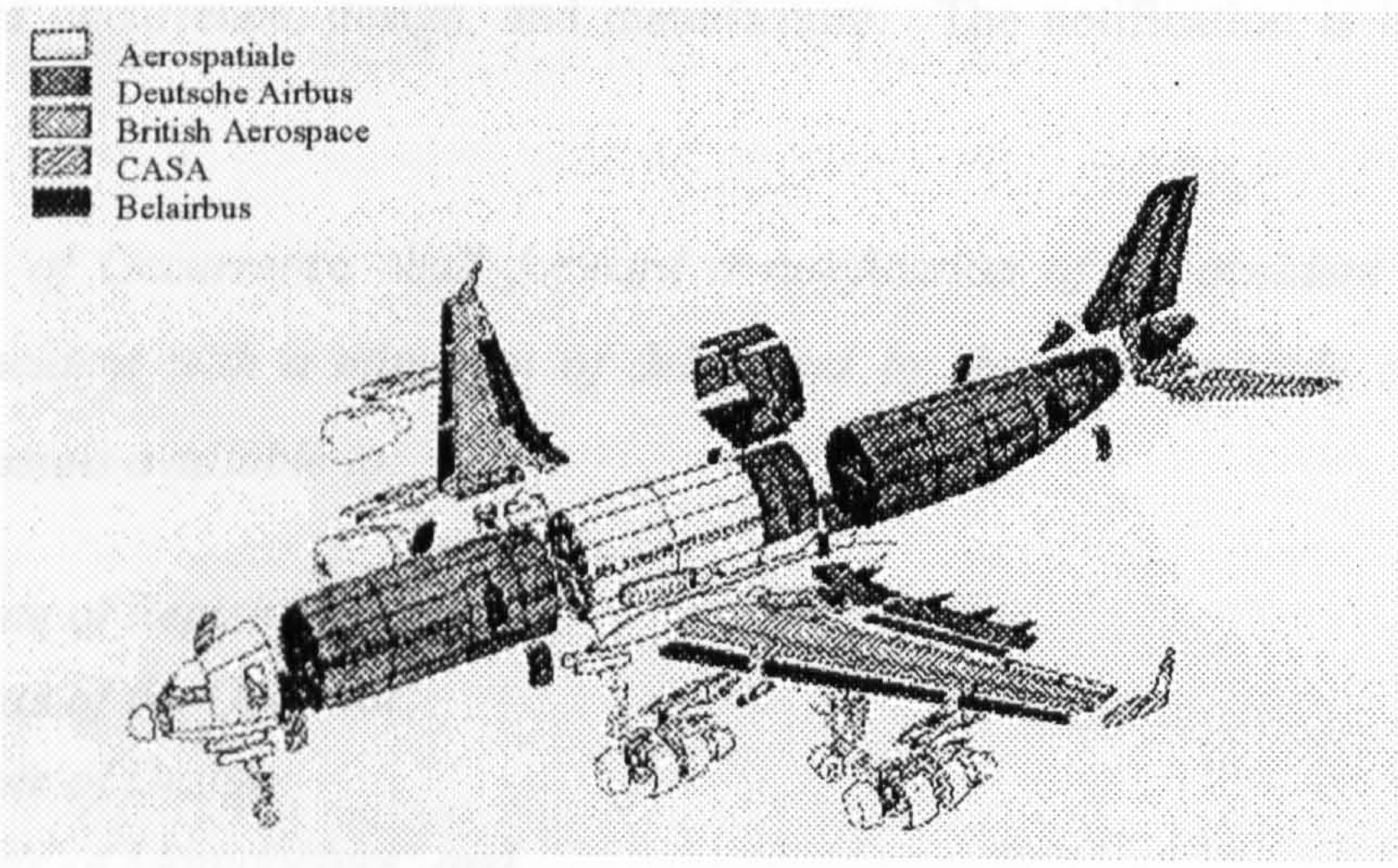
Whether it is realised or not, it is the customers that are paying for the overall accident costs, including insurance premiums, product liability costs, as well as the lawsuits and settlements following many accidents. Singleton (1987) indicated that the overall cost of accidents in society is in the order of magnitude of 2 per cent of Gross National Production and that the costs of frequent lawsuits consume more than 10 per cent of the gross earnings.

In brief, the cost of accidents is far beyond to be afforded, not only because it is growing faster than the rate of inflation, but because it heightens the cost of safety, especially when an accident investigation is called for.

## 2.3 Treatment after aircraft accident

### 2.3.1 The challenge for accident investigation

Not only because global interdependence is gradually formed, but because many aircraft manufacturers and airlines are in alliance with their counterparts, aircraft may be designed, manufactured, and assembled, and served in different countries. It is also possible that an aircraft is based in one country, registered in another country, leased to a third country, and maintained and serviced in other countries (see figure 2.2).




Wing final assembly/equipping: Deutsche Airbus

**Figure 2.2 A330/A340 production sharing**
Source : Airbus Industrie

Therefore, it may be difficult to identify precisely where operational control and where responsibility for safety lies. In addition to aircraft, aircrews, such as pilots, first officers, and flight attendants, probably come from different countries. Aviation is such a global industry, you cannot really solve safety problems by just working in your own country. Once an accident happens, the accident investigation authority of the State of Occurrence might need to be prepared to work effectively with other accident investigation authorities from several nations, and to share information and experiences with one another. International co-operation is required to undertake a complete accident investigation; otherwise, the findings will be suspect and the investigation may not produce credible recommendations to correct safety problems. In other words, the investigation can not extract useful lessons from the aeroplane accident to develop improvements and prevent future accidents.

### 2.3.2 Notification of an accident

In today's increasingly globalised environment, no matter contracting or non-contracting states of ICAO should understand international treaty and obey its standards and recommended practices. Chapters 4 and 5 of ICAO Annex 13 in the eighth edition amended in 1994 provide important notification about responsibilities of the states of occurrence, design, and manufacture. The notification is listed as follows:

*The State of Occurrence shall forward a notification of an accident or serious incident with a minimum of delay and by the most suitable and quickest means available to:*

*a) the State of Registry;*
*b) the State of the Operator;*
*c) the State of Design;*
*d) the State of Manufacture; and*
*e) the International Civil Aviation Organisation, when the aircraft involved is of a maximum mass of over 2,250 kg.*

*However, when the State of Occurrence is not aware of a serious incident, the State of Registry or the State of the Operator, as appropriate, shall forward a notification of such an incident to the State of Design, the State of Manufacturer and the State of Occurrence.*

*Upon receipt of the notification and a request by the State of Occurrence for participation, the State of Design and the State of Manufacture shall:*

*a) in the case of an accident or serious incident to an aircraft of a maximum mass of over 100,000 kg, inform the State of Occurrence of:*
   *1) the name of its accredited representative; and*

*2) whether the accredited representative will be present at the investigation and, if in the affirmative, the expected date of his or her arrival; and*

*b) in the case of an accident or serious incident to aircraft other than those specified in a) above, inform the State of Occurrence whether it will appoint an accredited representative. If such a representative is appointed the same information required under a) 1) and 2) shall be provided.*

If accidents or serious incidents occur outside the territory of any state, the State of Registry is responsible for the conduct of the investigation. However, it may delegate the whole or any part of the investigation to another State by mutual arrangement and consent. States nearest the scene of accident in international waters are obliged to provide assistance to the State conducting and controlling the investigation. The ICAO Manual of Aircraft Accident Investigation (Doc 6920) provides information in investigation procedures and technical guidance. Furthermore, its appendix lists the countries which may provide expert assistance and facilities for major accident investigation.

### 2.3.3 Cross-border co-operation

Generally speaking, countries which have large aviation manufacturers own relatively large safety organisations and accident investigation agencies. Countries with limited budgets and resources should consider what capability they have and give priority to what is urgent and important, such as regulating aircraft accident emergency operational procedures and maintaining good working relationships with foreign investigation authorities.

What maintaining relationships means is a recognition of the need for taking the time and effort to work together. It includes an acknowledgement of sharing mission and responsibility in dealing with both international and domestic accidents, a willingness to establish the necessary channels of communication, and a commitment to participate in the development of the required procedures. As to domestic accidents, such international co-operation is needed, especially in those countries with insufficient facilities and fewer experts. The act of interconnection essentially shows a recognition and understanding of the global interdependence. However, developing countries or countries with poorer safety performance are apt to act conservatively on sharing safety information. Thus, the initial contact with colleagues from the investigation agencies of other countries all too often begins with the notification of an accident.

## 2.4 Application of ICAO documents

Besides ICAO Doc. 6920 mentioned in the previous part, ICAO Doc. 7603, Information on National Civil Aviation Departments, is also a referential manual. It provides an informative directory of aviation authorities in member states of ICAO. It gives the names, position titles, telephone and facsimile numbers, mail and telex addresses and, in many cases, considerable information on the organisation structure for key civil aviation offices in each state. This information helps aviation authorities to know how counterpart agencies in other countries are organised, who their key officials are, and how to contact them. Their organisation structure also exposes whether or not the agency in question is independent of the civil aviation administration and that state's department of justice, for autonomy in civil aviation accident investigation authorities can ensure a position of objectivity. This may have an important influence on the way the agency carries out its investigation when a serious accident occurs.

The aim of international co-operation is to establish a robust conduit through which investigators may share information and experiences. By studying ICAO Doc 7603, an investigating agent can decide which countries are of primary interest. Then, formulating action plans, such as opening a dialogue, developing understanding of each other's mission and objectives, can be followed. Because the main purpose of co-operation is to advance aviation safety, in many cases the initial contact is mainly to facilitate mutual understanding and discuss assistance likely to be needed and provided in the future.

Once an accident or incident occurs, and if the country of occurrence knows about the other countries' facilities and capabilities and has built up confidence with their investigation authorities, the investigators of both sides are likely to contact in person, or over the phone, and sincerely discuss where problems lie with the course of investigation. Problems needed to be discussed are, for example, how to deal with the press and TV media especially on releasing information apt to be sensitive and possibly misinterpreted, how to conduct the investigation and what procedures should be given priorities. This is an ideal situation, but if it can be achieved, it will greatly benefit the progress of investigation and assist accident prevention in the future.

## 2.5 Measurement of airline safety

Constructing a measurement of airline safety is useful for two reasons. Firstly, it provides information about comparative safety performance among regions or airlines, and helps both aviation personnel and passengers to assess the possibility of flying risk in terms of regions and types of aircraft. Secondly, it serves as a useful starting point for more detailed analysis of why safety performance varies so much across carriers, nations, and regions.

### 2.5.1 Sources of possible error in the collection of accident statistics

Statistics play an important role in accident prevention. To prevent misleading and misrepresentation, some sources of error hindering a uniform system of accident reporting should be noticed:

a) Geographical or organisational variations in the definition of certain accidents.

   Different definitions, as described in section 2.1, may yield different statistics. The obstacle will not be overcome until all jurisdictions employ similar definition for classifying accidents.

b) Deliberate or negligent suppression.

   There are several forms of suppression, one of which is administrative self-protection. In an organisation or country with a higher accident rate, the purpose of keeping the accident rate down might distort accident statistical analysis. However, most of these errors are either partly or totally unavoidable because there are certain problems peculiar to data gathering.

c) Lack of uniformity in collecting and recording techniques.

   Tallying the number of known accidents is more complicated than it would seem to be. Conceivably, reports from under developing countries might reveal a lower rate of accident occurrence than do reports from developed countries.

### 2.5.2 Measurement of accident rate

Traditionally, airline safety statistics have used (1) flying-hour measurement, (2) departure-based measurement and (3) seat-kilometre measurement as exposure bases to calculate accident rates.

The first measurement constructs accident rates by flying hours, while the second and the third measurement construct accident rates respectively by the number of flights and the distance of available seats travelled. When calculating rates, sets of data used must be compatible and statistics must be used with caution in order to provide valid means of comparison. With the advent of wide-bodied aircraft, not only the number of available seats has increased but the duration of each flight has been lengthened. Moreover, if flying hours and seat/kilometres are measured to compare accident rates, short-haul flights will have higher accident rates than long-haul flights. Take the Taiwan case as an example, all domestic flights are less than 300 miles, the adaptation of flying hours or aircraft-kilometres to calculate accident rates will not be reasonable when compared with world-wide accident rates. In addition, most accidents occur on phases of takeoff, initial climb, final approach, and landing, irrespective of how long each flight has been airborne, how far it has flown, or how many seats it has. Accordingly, it may be more appropriate to compare numbers of accidents with numbers of flights than the numbers of flight hours or seat/kilometres.

Boeing's statistics of world-wide commercial jet accidents for 1959-1993 (see figure 2.3) shows that taking off and landing are the most dangerous moments during the flight time. These phases are what we call "time to cross your fingers". Although takeoff, initial climb, final approach, and landing comprise 6% of the flight time, 70 % of accidents occur during these four phases. This is called the "Window of Safety". When we safely pass the Window of Safety, flying danger is reduced substantially. As a result, most aviation safety professionals adopt one million departures rather than total flying hours or seat/kilometres to calculate accident rates.

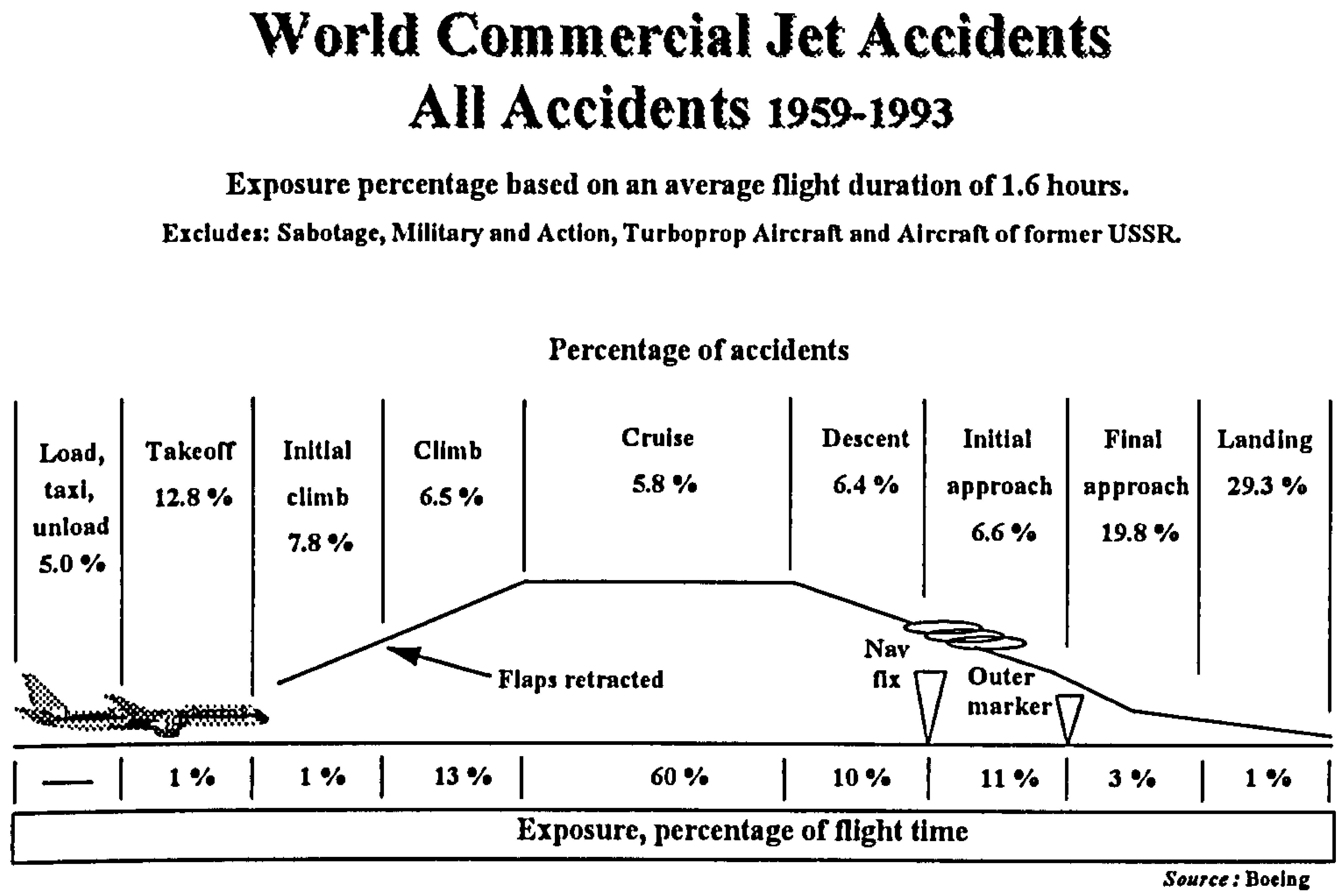



**Figure 2.3 Ratio of Flight Time and Accidents**

### 2.5.3 Risk in air travel

Table 2.1 shows the fatal accident record of the world-wide "scheduled" commercial airlines for 1977-1993. The data does not include CIS (Commonwealth of Independent States) and China. The first three columns give the region, the number of fatal crashes, and the number of fatalities. The fourth column gives the average percentage of passengers killed in these fatal accidents. The fifth column in the table shows the odds per 1 million flight departures of being involved in an accident in which someone is killed. The final column gives the resulting chances per 1 million flight departures of an individual passenger being killed in airline travel. As shown in the table, there is considerable variation among regions. Australia and New Zealand have the best safety record, with the chances of being killed in an aircraft crash about 0.7 in a million. For North America, the chance of being killed was about 0.8 in a million, exemplary safety records. Unfortunately, safety performance is markedly worse in some regions of the world. The chances of being killed in an aircraft crash in the Middle East, Asia, and Latin America were 4.3, 4.7 and 6.6 times worse than in

Australasia. Africa had the worst safety record, with a death risk per flight of about 8 per 1 million, more than 10 times worse than Australasia.

**Table 2.1**
**Accident and Fatality Record by Region, Scheduled Passenger Flights**
**1977-1993**

| Region | Number of Fatal Accidents | Number of Fatalities | Percent of Passengers Killed in Crash | Fatal Accidents per 1 Million Departures | Death Risk per 1 Million Departures |
|---|---|---|---|---|---|
| Asia | 76 | 3281 | 72 | 4.96 | 3.47 |
| North America | 72 | 2092 | 66 | 1.25* | 0.82** |
| Latin America | 71 | 2614 | 81 | 6.16 | 4.91 |
| Europe | 73 | 3303 | 68 | 2.69 | 1.82 |
| Australasia | 5 | 31 | 72 | 1.04* | 0.74** |
| Middle East | 19 | 1432 | 67 | 4.61 | 3.18 |
| Africa | 35 | 1185 | 74 | 10.88 | 8.05 |

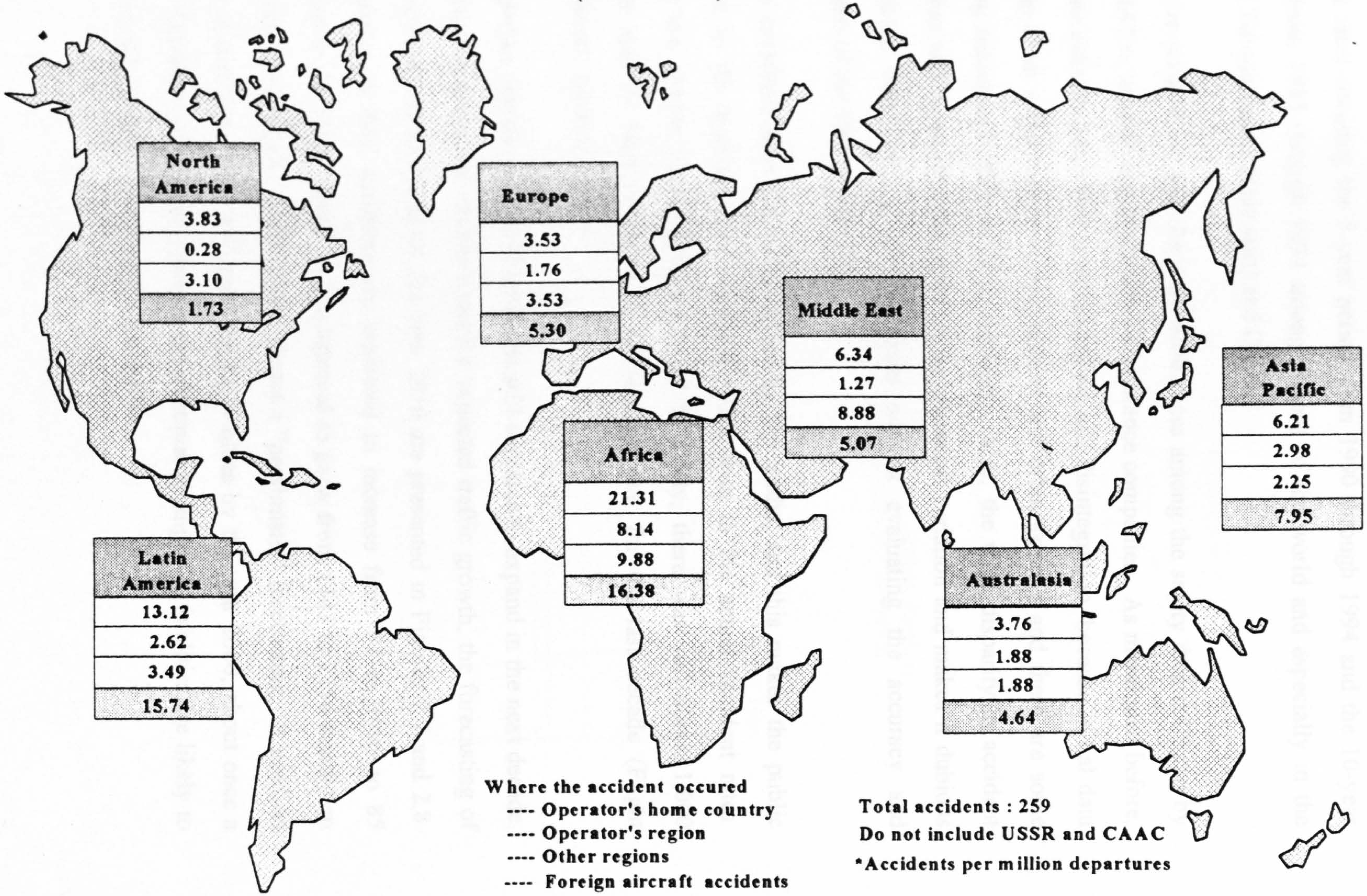
Source: Compiled from Flight International, WAAC, ICAO's ADREP, various years, and Oster, 1989.
* The North American and Australasia accident rate is lower than the Latin American, Asian, African, and Middle Eastern rates at the 90 percent confidence level.
** The North American and Australasia death risk is lower than the Latin American, Asian, African, and Middle East rates at the 90 percent confidence level.

Figure 2.4 shows the statistics of the accident rates of "international scheduled" passenger flights from 1984 to 1993 in the major geographic regions of the world as compiled from ICAO, Flight International, and World Airline Accident Summary of UK-CAA. The total of 259 accidents were counted, not including CIS and China. The accidents rates are computed by per million departures. There is also a considerable variation in the safety record among regions. Four sets of figures are listed under each region. The first set of figure is the accident rate of operator's home country. The second, the accident rate of operator's region. The third, the accident of other regions. And the forth, the accident rate of foreign aircraft accidents. Take Japan Airlines (JAL) as an example, the accident rate of JAL occurring in Japan, the operator's home country, was 6.21. The accident rate of JAL occurring in any Asian countries other than Japan, such as Singapore or Hong Kong, was 2.98. The accident rate of JAL occurring in other regions, such as North America or Europe, was 2.25. The accident rate of airlines from other regions occurring in Asia was 7.95.

According to the figure, North American (3.83), Australasian (3.76), and European (3.53) accident rates in the operator's home country from 1984 to 1993 were lower than the Latin American (13.12) and African (21.31) accident rates. Also, international scheduled passenger flights to/from North America (0.28) and Australasia (1.88) had better safety records than any other region. The accident rate of Australasian airlines occurring in other regions was 1.88, the best record among those of the other regions. With regard to foreign airline accidents, the rate for North America (1.73) was much lower than any other regions' rates. The last set of figures also showed that foreign airline accidents were more likely to occur in developing regions than in developed regions during that period.

Figure 2.4 Worldwide Airline Accident *Rates by Region : International Scheduled Passenger Flights

( 1984 -1993 )




Source : ICAO, Annual Statistics, Flight International , various years, and UK CAA, World Airline Accident Summary

HERO/ WPP006

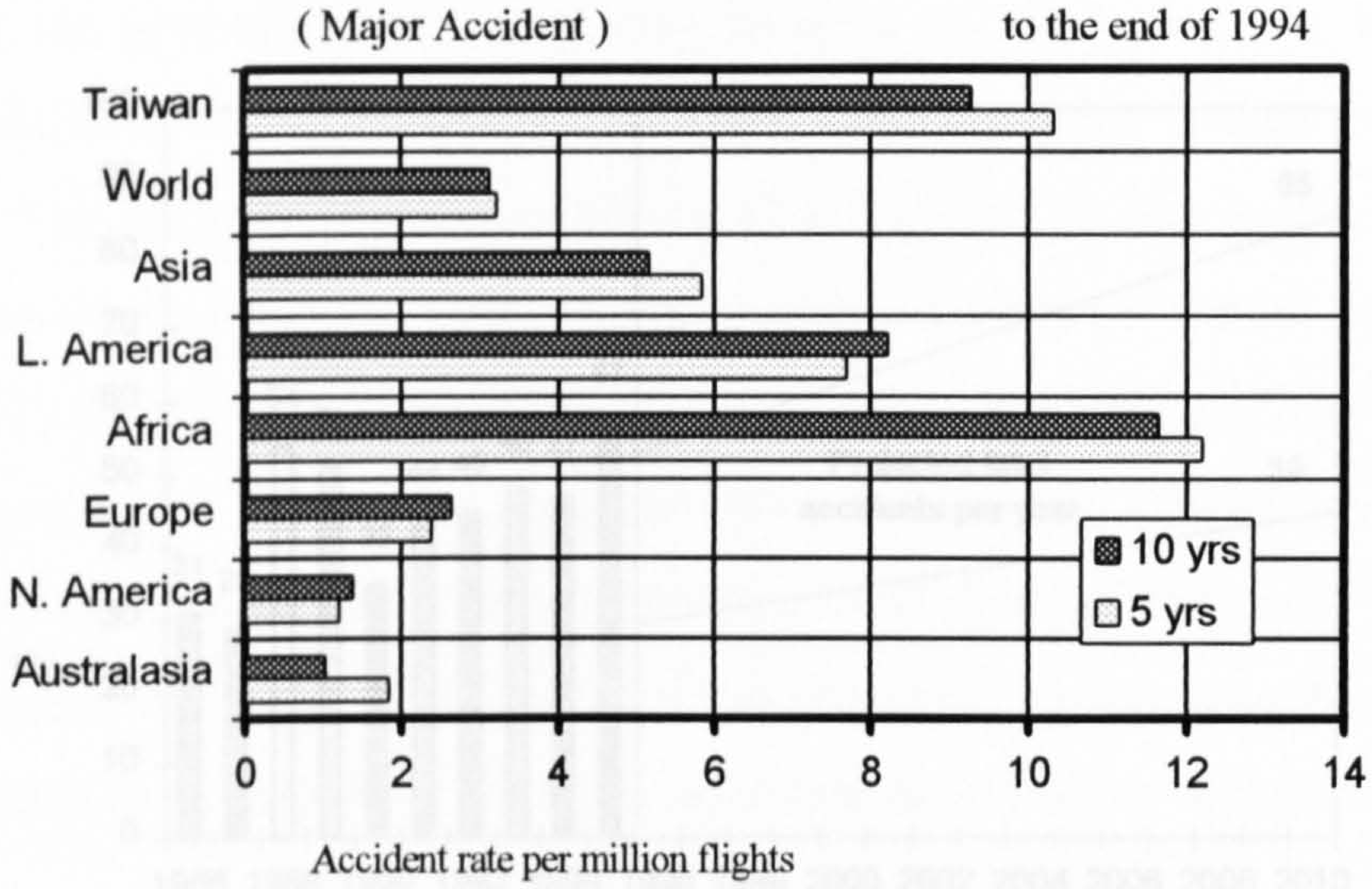
### 2.5.4 Jet carriers safety performance by regions

The data of figures 2.5 and 2.6 is extracted from "The Jet Operator" of Airclaims, an insurance company in the UK. These figures indicate the commercial jet aircraft accident rates covering the 5-year period from 1990 through 1994 and the 10-year period from 1985 through 1994 among regions of the world and especially in the areas of Taiwan (main study area) and China.

It must be pointed out that there are differences among the safety data collected by ICAO, IATA, aircraft manufacturers, or insurance companies. As mentioned before, these data sources have their own limitations and disintegration, because initial data reporting from some nations is inconsistent and often sketchy and there are some reporting biases and differences in numbers. Also, the wide disparity in accident definitions and measurements often causes statistical variation and makes it dubious to compare data from different sources without evaluating the accuracy and limitations of the various data first.

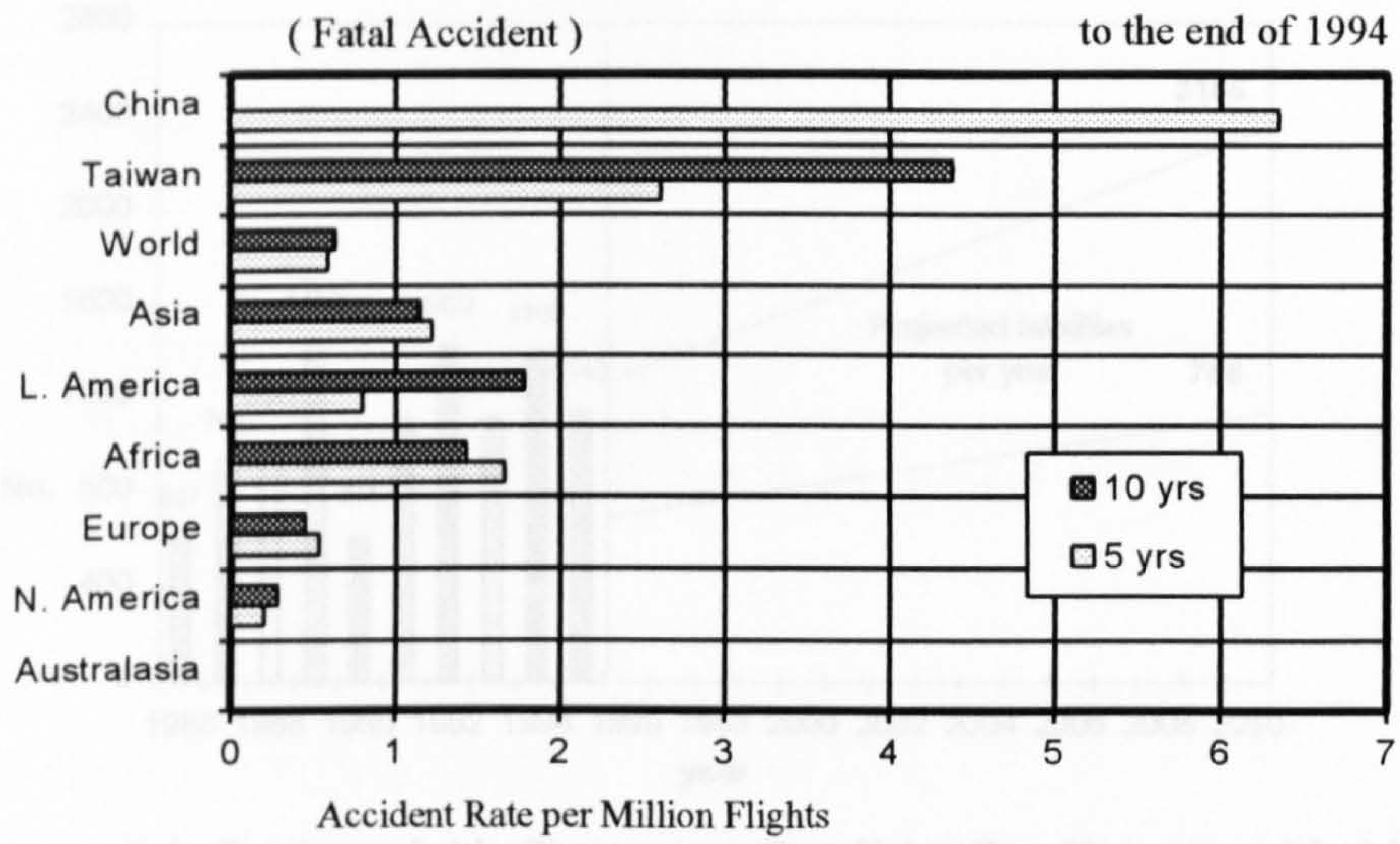
Aircraft accidents have been highlighted by the media, and this makes the public sensitive to the high-visibility accidents rather than to the actual accident rates. Despite the almost 100-fold improvement in safety, there was still about 1,000 fatalities and 40 fatal accidents in an average year for the last decade (Flight International, January 1994).

It is expected that the growth of air traffic will continue to expand in the next decade. Based on past ten years' accident rate for expected traffic growth, the forecasting of fatal accidents and fatalities by the year 2010 are presented in Figures 2.7 and 2.8. The number of fatal accidents are predicted to increase from 57 in 1995 to 85 maximum in 2010, and fatalities are expected to grow from 1143 to 2156 maximum during the same period. Boeing also shows a "pessimistic" forecasting. It predicts that the annual hull losses will reach up to 53 times by the year 2000, about once a week. Therefore, if accident rates do not continue to improve, fatalities are likely to be higher and much unacceptable by the public.




Source: Derived From UK CAA & Airclaims Data

**Figure 2. 5 Airline Accident Rates in Various Regions**
Western-built Jet Airlines (Major Accidents,1985-1994)




Source: Derived From UK CAA & Airclaims Data

**Figure 2. 6 Airline Accident Rates in Various Regions**
Western-built Jet Airlines (Fatal Accidents, 1985-1994)

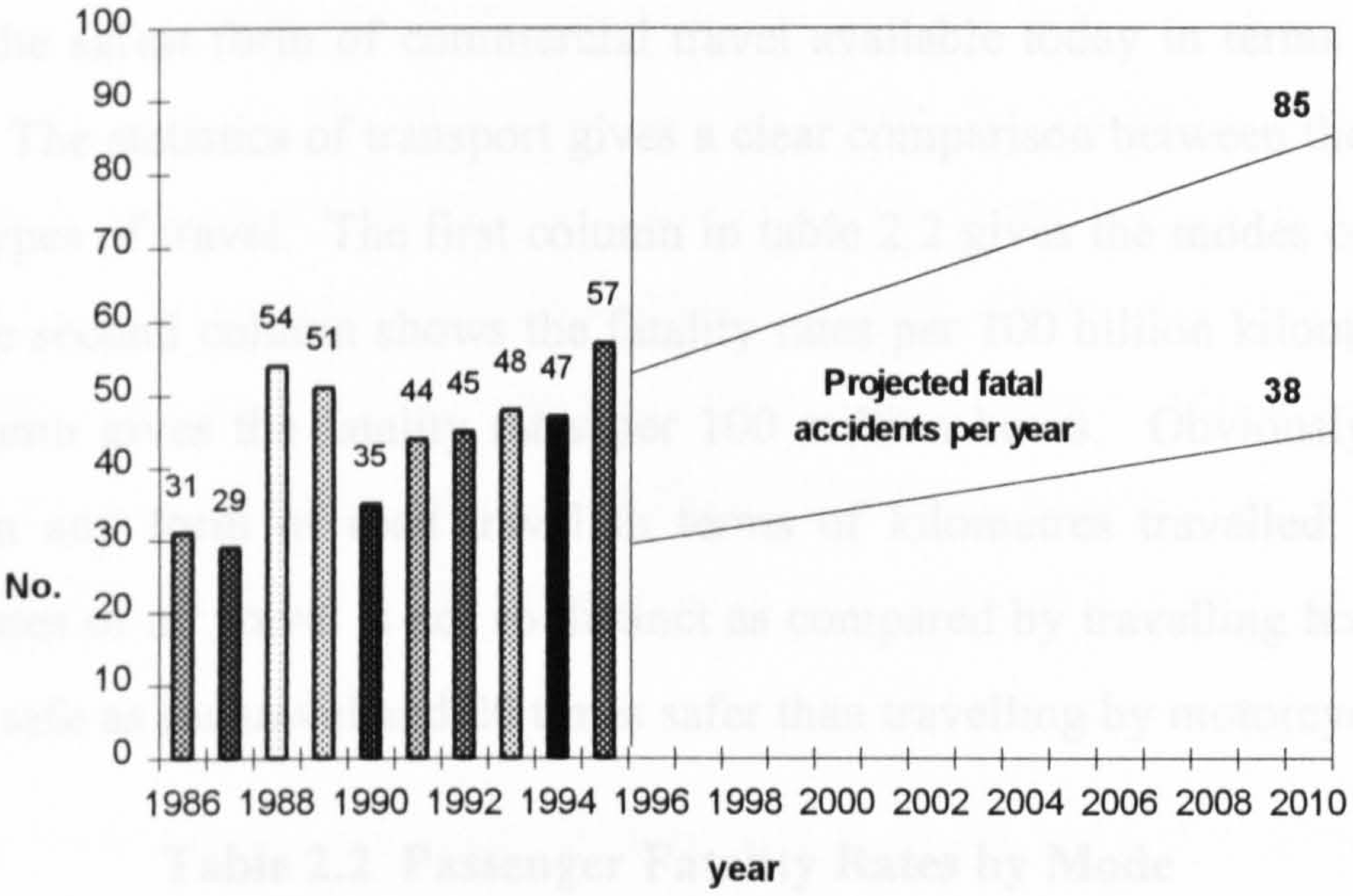



**Figure 2.7 Projected Fatal Accidents Per Year (worldwide)**
Base on past 10 years' accident rate and expected traffic growth

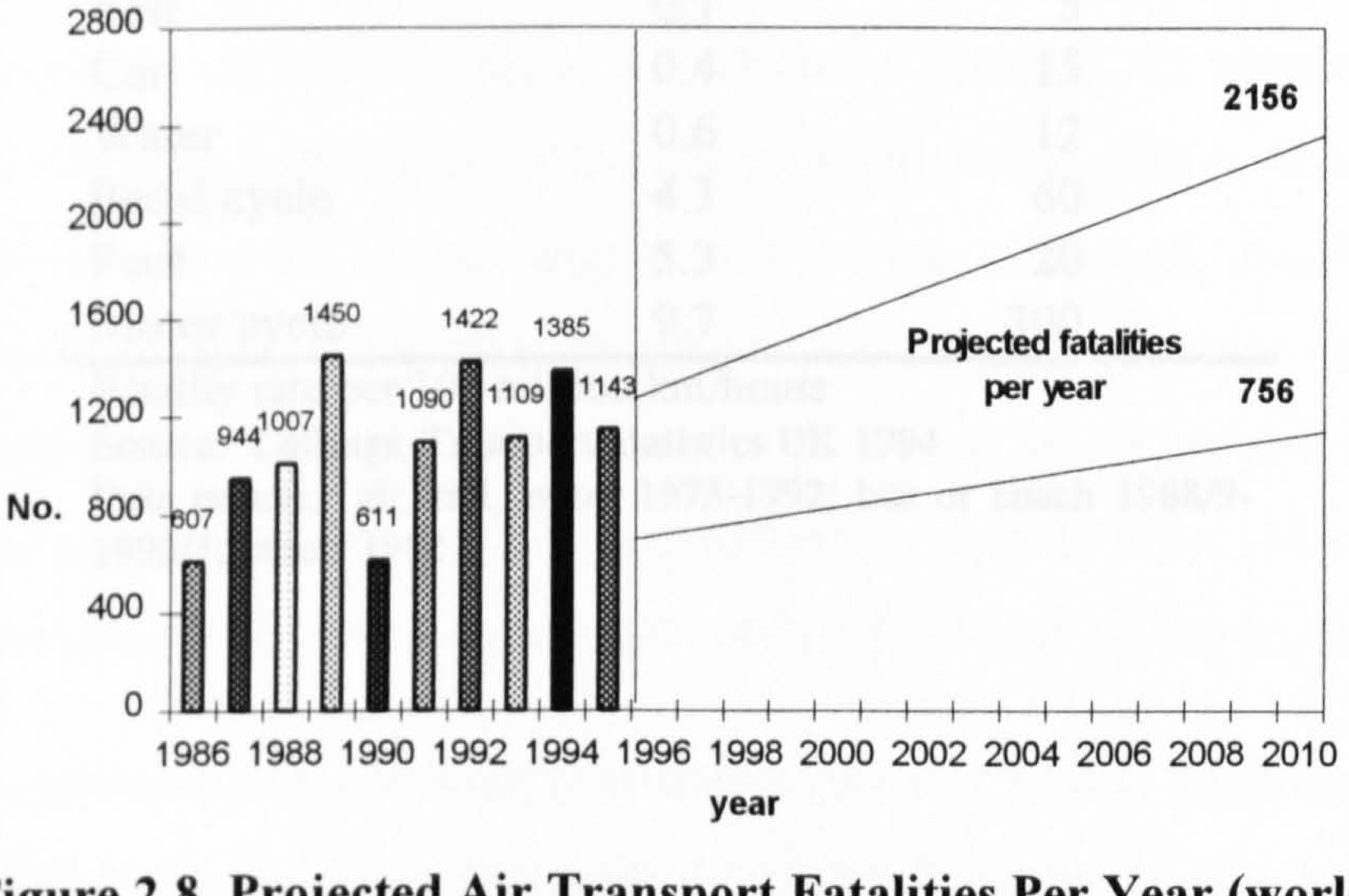



**Figure 2.8 Projected Air Transport Fatalities Per Year (worldwide)**
Base on past 10 years' number of fatalities and expected traffic growth

### 2.5.5 The safest way to travel: Air transport

Although the growth of air travel may increase accident rates, air transportation remains the safest form of commercial travel available today in terms of travelling mileage. The statistics of transport gives a clear comparison between the safety of the various types of travel. The first column in table 2.2 gives the modes of air and road travel, the second column shows the fatality rates per 100 billion kilometres, and the final column gives the fatality rates per 100 million hours. Obviously air travel is safer than any form of road travel in terms of kilometres travelled. Though the fatality rates of air travel is not so distinct as compared by travelling hours, air travel is still as safe as car travel and 20 times safer than travelling by motorcycle.

**Table 2.2 Passenger Fatality Rates by Mode**

| Mode | Passenger kilometres | Passenger hours |
|---|---|---|
| Air | 0.03 | 15 |
| Bus or coach | 0.04 | 0.1 |
| Rail | 0.1 | 5 |
| Car | 0.4 | 15 |
| Water | 0.6 | 12 |
| Pedal cycle | 4.3 | 60 |
| Foot | 5.3 | 20 |
| Motor cycle | 9.7 | 300 |

Fatality rate per 100 million km/hours
Source: Collings, Transport Statistics UK 1994
Data period: air, rail, water 1975-1992; bus or coach 1988/9-1992/3; others 1992

## 2.6 Analysis of accident contributing factors

### 2.6.1 Analytical methods to accident investigation

Overall safety records are a useful index to identify safety performance between regions or airlines of the world and can be useful for assessing whether safety is improving or worsening over time. However, little understanding is provided about why safety has been worse in some segments than in others, and so is little guidance about where to focus efforts to improve safety. Thus, there is a need to select a more critical approach beginning with classifying accidents according to their cause and comparing the distribution of causes ,both over time and across segments of the industry.

For many years, focus has been on assigning a single cause for accidents, but the problem is that many accidents have several contributing factors and these factors, though not the last link in the chain of events, are more reliable to reflect actual causes. Nowadays, most advanced aircraft and aviation systems have functions of redundancy and fool-proof systems to avoid the occurrence of accidents. Therefore, a single failure is unlikely to cause an accident. Despite the primary cause, the occurrence of an accident must involve other system malfunction or failure. Consider the example where an aircraft engine fails during a take-off, running on a wet runway, and the pilot fails to take the proper action to land the plane safely, resulting in its veering off the runway. Obviously, both the engine failure and the pilot error caused the accident, and the wet runway made the situation worse. There would have been no accident if either the engine had not failed or the pilot had acted correctly.

The most common accident analytical approaches are "Events Sequencing" and "All Cause/Multiple Cause". The approach of "Events Sequencing" is to select the cause that initiated the sequence of events leading up to an accident - in this case engine failure. While the other approach of all cause/multiple cause emphasises the need to identify the primary cause which is most responsible for the accident or after which the accident was inevitable - in this case the failure of the pilot to take proper action. It is obvious that both approaches oversimplify accident situations. Ferry in his book of 1988, Modern Accident Investigation and Analysis, distinguishes over twenty types of accident analysis approaches. However, there is no one approach better than another. It is a matter for the investigation agencies to seek better approaches to suit their needs and capabilities when conducting an investigation. Below is the list of analytical methods used in accident investigation:

- Events sequencing.
- Known precedent.
- All cause/multiple cause.
- Codes, standards, and regulations (CSR's)
- The four M's of man, machine, media, management (add mission for a fifth).
- Re-enactment.
- Reconstruction (of wreckage).
- Simulation.
- Epidemiological.
- Hazard analysis documentation.
- Inferential conclusions.
- Program evaluation review technique (PERT).
- Critical path method (CPM).
- Failure mode and effect analysis (FEMA).
- Technique for human error rate prediction (THERP).
- Fault tree analysis (FTA).
- Change analysis.
- Management oversight and risk tree (MORT).
- Multilinear events sequencing (MES).
- Technique of operations review (TOR).
- Scenario modelling.
- Preliminary hazard analysis.

### 2.6.2 Causal factors in accidents in Asia and Taiwan

The occurrence of accidents are mostly caused by multiple factors- either active or latent factors. Though for each accident a judgement has been made of the apparent or probable causal factors, it should be noticed that the judgement on such limited reported details cannot be assumed always reliably to reflect the actual causes but a useful indicator of the relative importance of the various factors.

Table 2.3 and 2.4 indicate for each category the ranking causal factors to fatal aviation accidents in Asia from 1983 through 1992, and aviation accidents and incidents in Taiwan from 1989 through 1994. The number of accidents where a given factor has been judged to have occurred is shown in the last column. The accident investigation reports of Asia are taken from aircraft manufacturers, related CAA and international civil organisations. As to Taiwan, its source is from the CAA, Taiwan. The data of Asia includes commercial jets only, and the accident abstract is listed in appendix A.

**Table 2.3**
**Causal Factors Attributed to Fatal Accidents**

(1983-1992)

| Category | Factor | No of Accidents where factor occurs |
|---|---|---|
| Crew | Failure to follow regulations or procedures | 21 |
| | Failure to cross-check / co-ordinate | 19 |
| | Lack of situational awareness | 17 |
| | Omission of action / inappropriate action | 13 |
| | Flight handling | 9 |
| | Fast / high on approach | 7 |
| | Lack of qualification / training | 6 |
| | Language barrier | 3 |
| | Action on wrong control / instrument | 2 |
| | Slow / low on approach | 2 |
| ATC / Ground aids | Incorrect or inadequate instruction / advice | 4 |
| | Failure to provide separation | 1 |
| | Lack of ground aids | 1 |
| Aircraft systems / Engine / Structure | System failure - reduce controllability | 3 |
| | System failure - other | 3 |
| | Engine failure | 1 |
| | Structural failure | 1 |
| Environment | Runway condition (slippery, standing water etc.) | 11 |
| | Thunderstorm / heavy rain | 9 |
| | Poor visibility | 7 |
| | Wind shear / turbulence | 1 |
| | Bird strike | 1 |
| Failings leading to impact with terrain | Collision with level ground / airport | 6 |
| | Collision with high ground | 3 |

Each accident may have more than one Causal Factor.
The total number of accidents is 48 and the average of causal factors per accident is 3.38.
Source: ICAO, Asian CAAs and aircraft manufacturers

**Table 2.4**
**Causal Factors Attributed to Accidents, Incidents**

(Taiwan)

| Category | Factor | No of Accidents where factor occurs |
|---|---|---|
| Crew | Failure to cross-check / co-ordinate | 17 |
| | Failure to follow regulations or procedures | 15 |
| | Lack of situational awareness | 14 |
| | Omission of action / inappropriate action | 6 |
| | Lack of qualification / training | 6 |
| | Flight handling | 4 |
| | Fast / high on approach | 3 |
| | Failure in look-out | 2 |
| | Slow / low on approach | 1 |
| Environment | Poor visibility | 5 |
| | Runway condition (slippery, standing water etc.) | 3 |
| Engine / Structure | Engine failure | 2 |
| | Structural failure | 1 |

Each accident may have more than one Causal Factor.
The number of accidents is 3 and the average of causal factors per accident is 2.82. The number of incidents is 25.
Source: CAA, Taiwan.

A total of 48 accidents has been considered in Asia and 162 causal factors allocated in all, an average of about 3.38 per accident. With regard to Taiwan for 1989-1994, there were 28 accidents and incidents with an average of 2.82 allocated causal factors. "Failure to follow regulations or procedures", "failure to cross-check/co-ordinate", "lack of situational awareness" and "omission of action / inappropriate action" are the most frequently occurring factors, all of which are listed by the "Crew" category. "Failure to follow regulations or procedures" is judged to have been a factor in 21 out of the 48 accidents (44%) in Asia and 15 out of 28 accidents (54%) in Taiwan. "Failure to cross-check / co-ordinate" is also striking with a total of 19 accidents (40%) in Asia and 17 accidents (61%) in Taiwan. All of these suggest that Crew Resource Management and training, human factors, professionalism, flight deck skills and operational procedures are the key areas to consider in reducing the number of accidents.

### 2.6.3 The relationships between aircraft accidents and pilot performance

It is well known that human error, especially pilot error, accounts for the majority of aircraft accidents. In order to explain the relationships between aircraft accidents and pilot performance, a conceptual model was created as shown in Figures 2.9-2.11. The left curve of the twin-peak model represents the environmental demands of pilot performance, and the right curve represents the actual pilot performance.. Environmental demands refer to the weather, aircraft condition, air traffic control, airport facilities, etc. (Figure 2.9) Whereas actual pilot performance include training, pilot's physical and psychological condition, crew co-ordination, and so on (Figure 2.10). The shaded area shows the possibilities of occurring accidents/incidents (Figure 2.11). In other words, accidents/incidents occur when pilot's performance does not meet the demand of the environment.

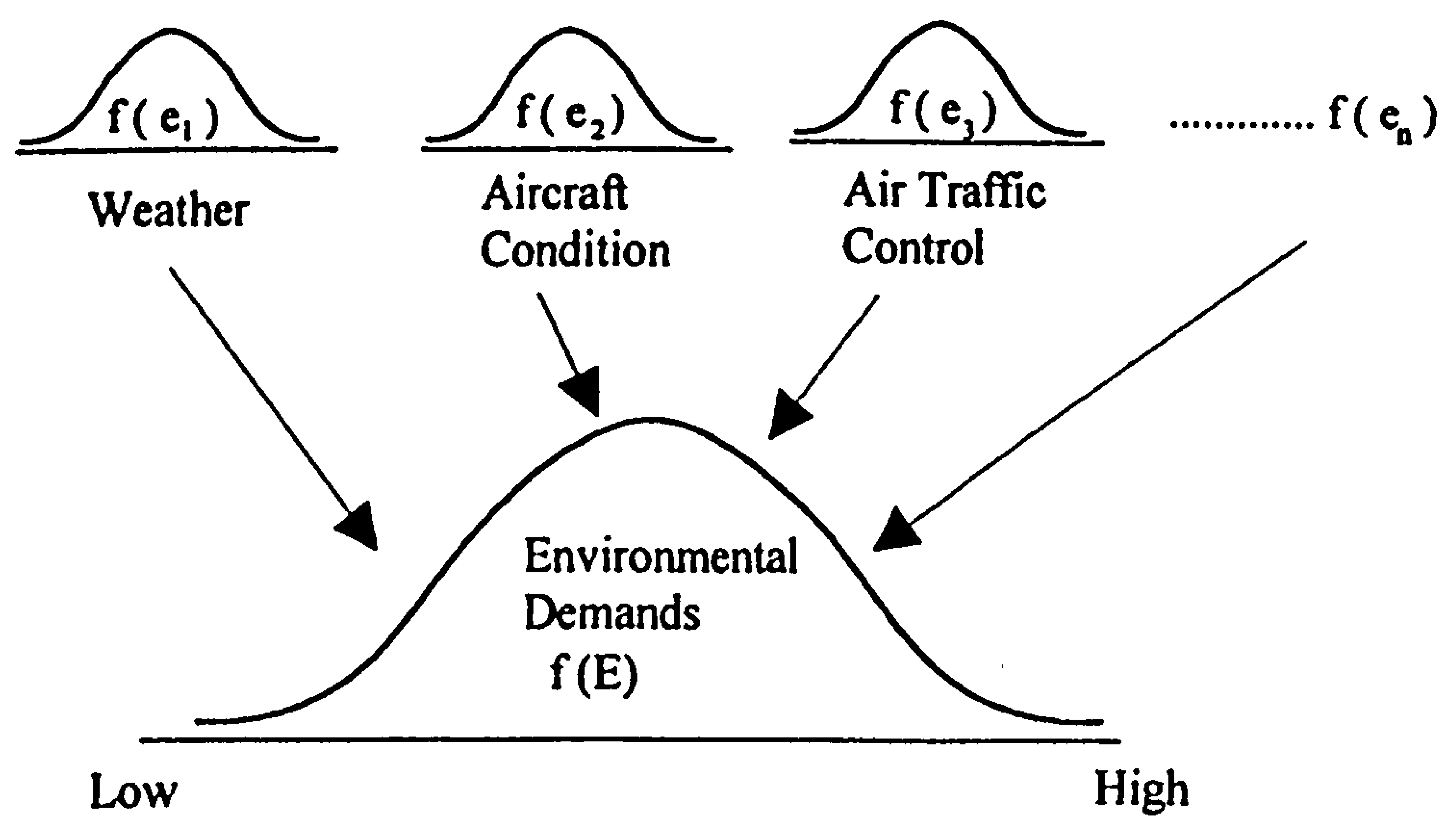



**Figure 2.9 Environmental Demands of Pilot Performance**

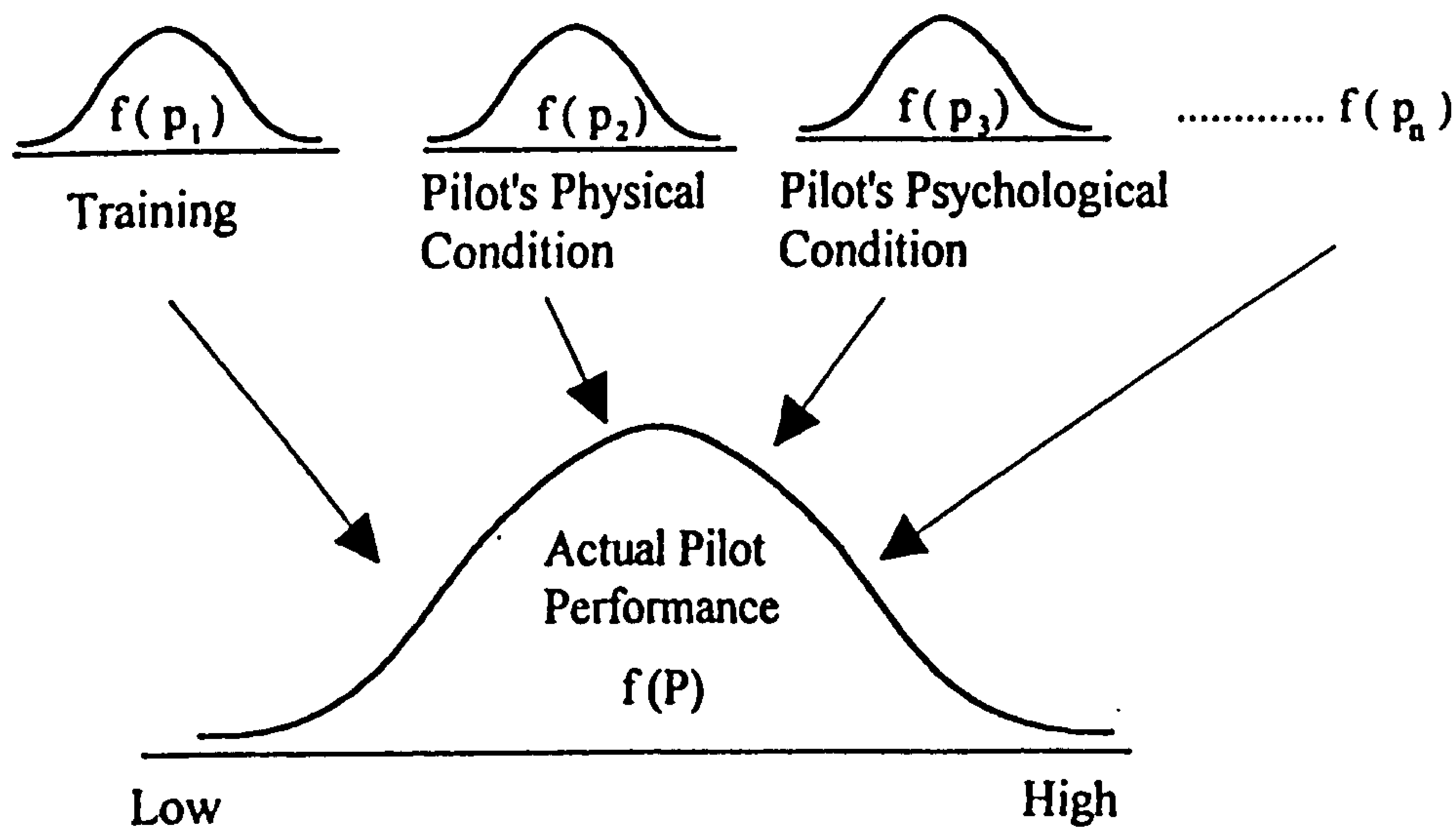



**Figure 2.10 Actual Pilot Performance**

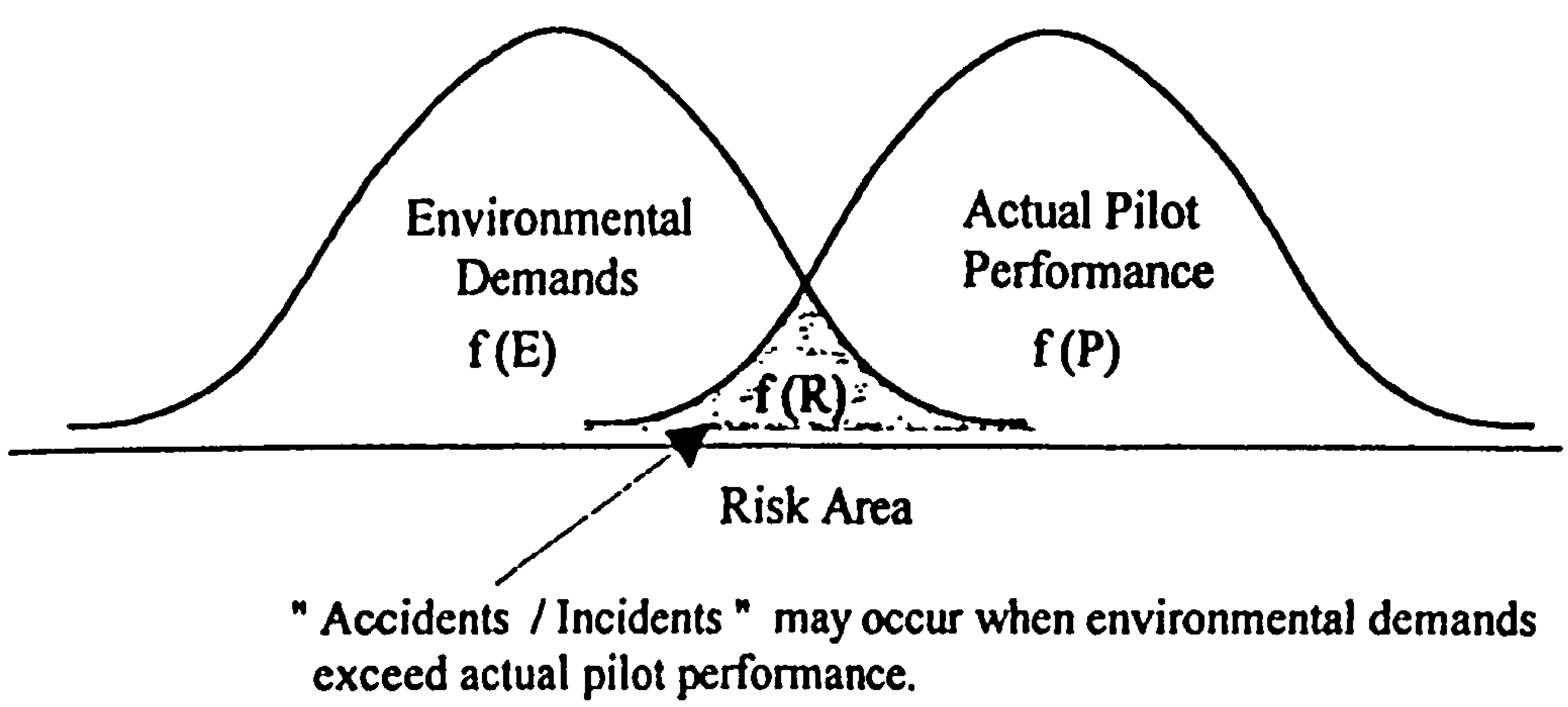



**Figure 2.11 The Twin-Peak Model: An Explanation of Why Aircraft Accidents Occur**

Mathematically, the twin-peak model can be expressed as follows:

f (R): The shaded area where the f (E) and f (P) distributions overlap is the chance of "accident" or "incident";

$f(E) - f(P) > 0$, or

$$f(e_1, e_2, e_3, \dots e_n) - f(p_1, p_2, p_3, \dots p_n) > 0$$

$$f(E) = f(e_1, e_2, e_3, \dots e_n)$$

$$f(P) = f(p_1, p_2, p_3, \dots p_n)$$

where

$f(E)$ = Environmental demands for pilot performance

$f(P)$ = Actual pilot performance

On 4 November, 1993 at about 0336 a China Airline Boeing 747-409B ran off the runway and entered the sea while landing. On the day of the accident, Hong Kong International Airport was affected by a strong gusty wind. In addition, it was raining and the runway was wet. Nevertheless, the airport didn't close and many aeroplanes had landed successfully. The investigation report (CAD, Hong Kong, 1995) found that the aircraft was capable of being landed normally under the weather conditions, and concluded that the captain might be the contributing factor to this accident.

This accident explains that when the environment's demand is almost the same, the pilot's performance can result in different outcomes. Pilot's performance is a variable; different pilots have different performance variance.

According to the model, there are two ways for safety management to reduce the risk of accidents/incidents. The first is to promote pilot performance and the other is to reduce environmental demands.

# CHAPTER 3

# CONTEMPORARY SAFETY THINKING AND ITS APPLICATION

"There are truths on this side of the Pyrenees which are falsehoods on the other."

----------- *Blaise Pascal*

## 3. Overview

The previous chapter of accident analysis highlights the fact that pilot error has directly contributed to the majority of accidents. However, if pilot error is assumed to be the only contributory factor in these incidents, the lessons learnt are too narrow to reveal the underlying root cause(s). In consequence, many warning signs are likely to be neglected and numerous opportunities for making safety improvements are lost.

Past accident investigations tend to explore the extent of technical causes and seldom look deeply into the contributions of management and organisation. A better approach is to adopt a broader and more penetrating investigation procedures.

How do management and organisation affect airline safety? Scientists have made great efforts when dealing with human factors, but the focus has always been on exploring how individual behaviour and attitude influence safety. Even though safety professionals in both civil and military aviation have perceived that management and organisation influence to accidents, it is not until recently that studies have confirmed that these issues have a profound role in the occurrence of accidents, especially in today's high-tech industry.

This chapter addresses the role of individual mistakes as being the indicators of more general these failures, and emphasises the importance of incident investigation and reporting in detecting system failure. The remaining sections of the chapter discuss the characteristics of safety culture, their links with accident rates. The necessity for the coherent safety documentation for ensuring system safety is also indicated.

## 3.1 Human failures in performance

Accident investigation is concerned with locating the cause or causes of accidents. Traditionally, these causes are defined as unsafe acts or unsafe conditions (see figure 3.1). In Chapter 2, the analysis of accident contributing factors has shown clearly that a high percentage of accidents are caused by unsafe acts. Precisely, most accidents are contributed to by human error. Hence, it is a reasonable supposition that understanding the primary causes of human error or unsafe acts, will greatly facilitate accident prevention. After all, accidents are intimately bound up with planned actions that fail to achieve their intention. If more details of how such failures occur were known, lessons could be applied to organisational planning and accident prevention programs in general.

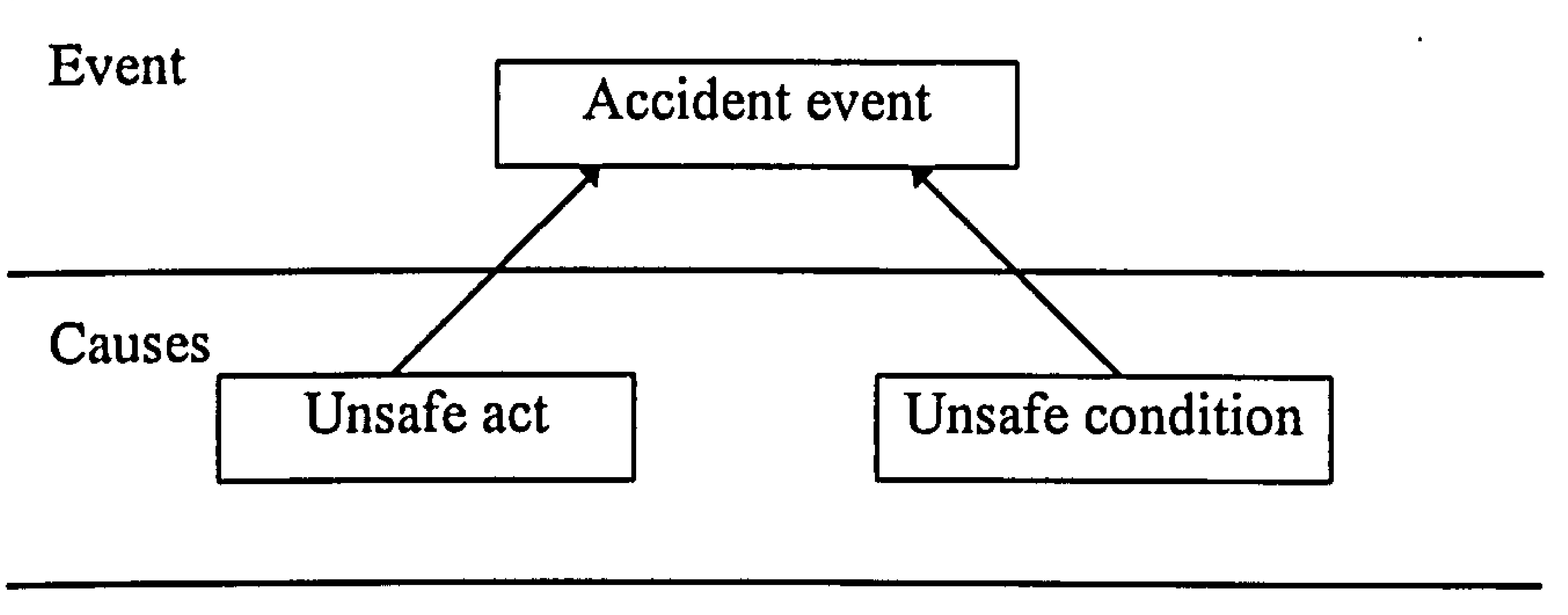



**Figure 3.1 Backtracking of Accidents**

Errors mean different things to different people. From a theoretical aspect, errors should be collected, cultivated and categorised, as they offer important clues about the covert control processes underlying routine human actions. In other words, a better understanding of mental processes can help in predicting and reducing dangerous errors. Ernst Mach (1976) put it well: "Knowledge and error flow from the same mental sources, only success can tell the one from the other."

### 3.1.1 Classification of human failures

Human failures are errors or violations committed by those in direct contact with the air transport system: pilots, air traffic controllers, maintenance mechanics and the like.

Error, in general, can be described as being of three primary types: slips, lapses and mistakes. Slips and lapses refer to actions deviating from current intention due to execution failures and/or storage failures, whereas mistakes occur when an intentional plan is inadequate for achieving its desired outcome. Slips and lapses stem from the unintended activation of largely automatic procedural routines; however, mistakes

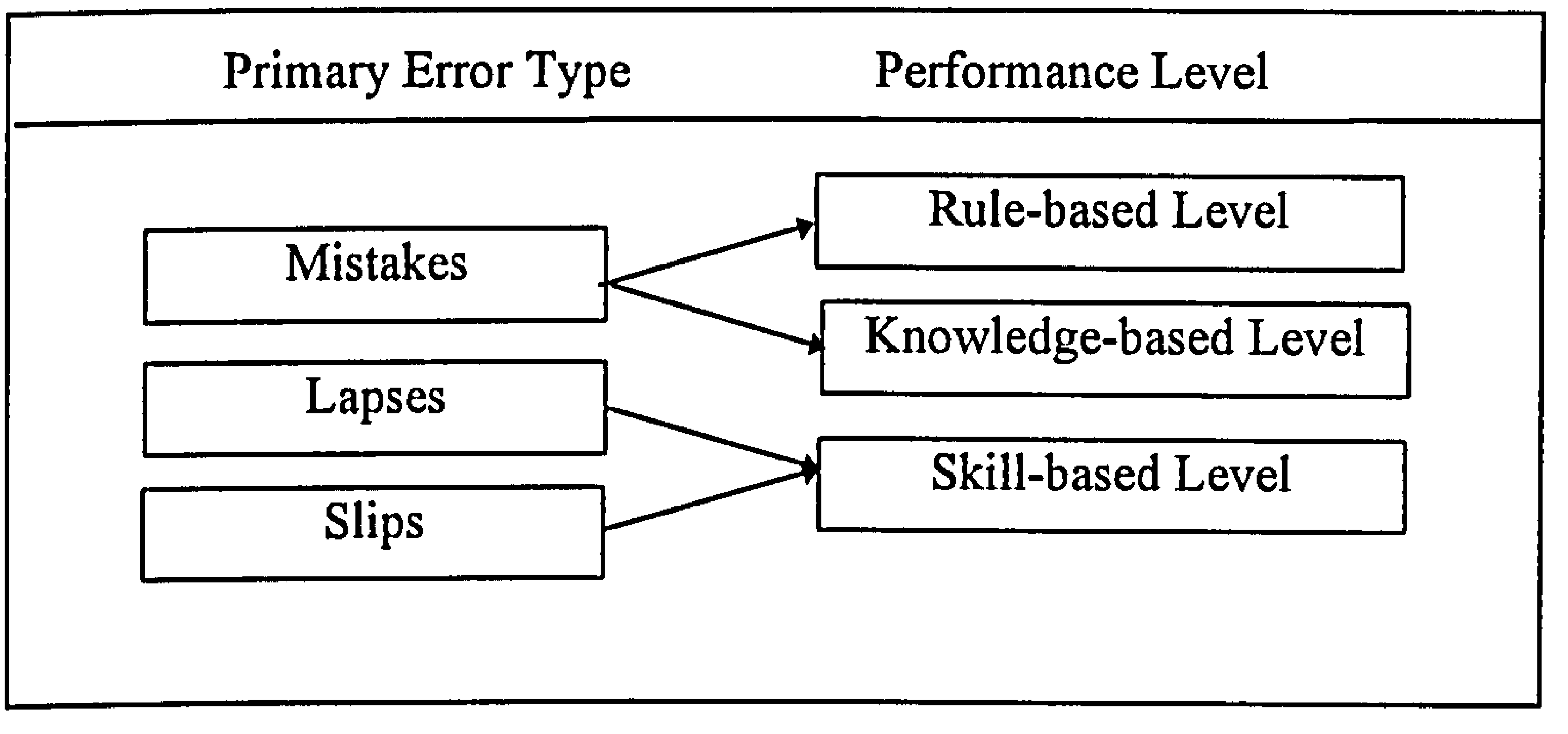



**Figure 3.2 Relating Three Primary Error Types To Rasmussen's Three Performance Levels.**

arise from failures of the higher-order cognitive processes involved in judging available information, setting objectives and deciding upon the means to achieve them. Essentially, slips and lapses are routine actions, and mistakes are problem-solving activities. However, the use of a simple slips/mistakes distinction is not sufficient to capture all of the basic error types. Some errors fall between the simple slip and mistake categories. They possess properties common to both. To resolve this problem, mistakes can be subdivided into rule-based mistakes and knowledge-based mistakes. Figure 3.2 proclaims the relationship between the three error types and Rasmussen's three levels of performance.

Errors are unintended and arise primarily from information problems. They can be reduced by improving the quality and the delivery of necessary information within the workplace. Differing from errors, violations are deviations from safe operating practices, procedures, standards or rules. Most of the time, such deviations are deliberate and associated with motivational problems. Violations, thus, require motivational and organisational remedies.

The three performance levels, addressed by Rasmussen also provide a principled basis for classifying procedural violations (see Table 3.1).

**Table 3.1 Relating error types and violation types to performance levels**

| Performance levels | Error types | Violation types |
|---|---|---|
| Skill-based | Slips and lapses | Routine violations |
| Rule-based | RB mistakes | Situational violations |
| Knowledge-based | KB mistakes | Exceptional violations |

Notwithstanding that there is no universally agreed classification of human failures, the existing taxonomies can be used in an attempted to identify causal mechanisms.

- Skill-based slips (and lapses): Skill-based behaviour occurs when an incoming piece of information is connected directly to an automatic response which can be stored patterns of pre-programmed instructions. Errors at this level can be grouped into two modes: inattention (omitted checks) and overattention (mistimed checks). Inattention refers to the failure to make an attentional check at critical nodes, particularly when the current intention is to deviate from common practice. Overattention occurs when an attentional check is made at an inappropriate moment during a routine action sequence. Such mistimed monitoring is most likely to occur immediately following a period of 'absence' from the task in hand.

Slips and lapses are associated with the following three kinds of executive failure:

- *Attentional slip* is the failure to monitor the current intention and proceed along the customary routine actions, often following a change in either intentions or the surrounding circumstances.
- *Memory lapse* is the failure to execute an intended action, usually after some delay intervenes. In other words, it is an absent-minded error.
- *Perceptual error* occurs because the recognition schemata accept look-alike for the intended object. In a highly routinised set of action, such a perceptual error is likely to occur because of the unnecessity to invest the same amount of attention in the matching process.

On the 10th January 1992, for example, an inexperienced first officer of the Boeing 737 made a hard landing at Madras, India, resulting in the right main gear collapsing and the right engine being dragging on the runway for about 6000 feet (Boeing, 1994).[6] This accident was the result of a skill-based slip.

- Rule-based mistakes: Rule-based mistakes involve the application of pre-packaged but inappropriate solutions to problems that people have either encountered many times before, or which they have been trained to handle. Errors at this level are associated with the misclassification of situations leading to the application of the wrong rule, or with the incorrect recall of procedures. Problem can occur here when anything requires some alternation of the current routine behaviour. Rule-based mistakes divide into two broad categories: the misapplication of normally good rules, and the application of bad rules (Maurino et al, 1995)

[6] Because of the limitation of data collection, some accident investigation reports collected from aircraft manufacturers are unofficial and used on a restricted basis in the thesis. However, where conflicts occur between the unofficial information and the final official reports, the official reports must be considered authoritative and take precedence.

- *Misapplication of good rules.* A 'good rule' is one that has proven perfectly adequate in a certain circumstance. The chances are that it is wrongly applied on a significantly exceptional condition sharing many common features with the usual problem situation. In other words, the misapplication of good rules arises from a failure to discriminate between appropriate and inappropriate problem situations.
- *The application of bad rules.* Bad rules arise from encoding difficulties or from deficiencies in the action component. In the case of the former, features of a particular situation are either not encoded or are misrepresented in the conditional component of the rule. The latter is the application of wrong, inelegant or inadvisable rules to solve a problem. Though use of a less-than-ideal way of tackling problems reach its aims most of the time, it can lead to a more acute problems later.

The accident at Kuala Lumpur, Malaysia, on the 18th December 1983 resulted from rule-based mistakes. The Airbus A300 impacted trees and terrain 120 metres short of the runway during final approach. It was concluded that the flight crew not only failed to follow procedural requirements, but these was insufficient monitoring during the approach in VMC (Visual Meteorological Conditions), so that the approach was continued to below the MDA (Minimum Descent Altitude) without having positive visual references. (ICAO Circular 196-AN/119)

- Knowledge-based mistakes: Knowledge-based mistakes occur when a person is attempting to solve a novel problem (i.e. one for which his or her training and/or experience has not provided a pre-programmed solution). This entails using conscious analytical processes and stored knowledge to reason what the problem is and what will solve it. Errors at this level stem from the limited capacity of working memory and the use of incomplete or inaccurate mental models of the problem situation.

The following example illustrates a knowledge-based mistake. In August 1994, an Airbus 300-600 overran the runway at Cheju, Korea whilst landing in flap configuration 15/20 from an ILS (Instrument Landing System) approach to a 9,800 feet runway[7]. The captain failed to recognise that a hazardous situation would be created by touching down coupled with significant windshear and heavy turbulence, so he selected a lower than normal Slat/Flap setting and increased the approach speed (Airbus, 1995).

- Violations at the skill-based level: Violations at the skill-based level often involve the application of something quickly and simply rather than following the proper procedure or rules. The routine use of such violations are promoted when they are rarely punished or compliance with rules is seldom rewarded.

- Violations at the rule-based level: Situational violations occur when current but unallowable actions are still carried out to achieve their ends, in the belief that they will not result in bad consequences, despite the fact that the actions have been prescribed and some modifications have been made to incorporate the lessons learned in the past incidents and accidents. Rule-based violations are seen very often when their benefits outweigh the possible costs.

- Violations at the knowledge-based level: Exceptional violations involve unexpected activities taking place in a novel or rare situation, especially where there is unlikely to be any procedural guidance or training to solve the problems.

  For example, on 4th August 1984, a BAC 1-11 overran into shallow seawater at Tacloban, Philippines, because the captain deviated to the right of the final approach track in order to show a war shrine to a passenger whom he had invited into the cockpit (British Aerospace, 1985).

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[7] The aircraft encountered landing/touchdown difficulties due to strong wind or possibly windshear. It landed long on runway and overran the runway, crashed through turf and impacted a drainage ditch. Just prior to touchdown and just before the aircraft overran the runway, it was found that the First Officer (PNF) interfered with the Captain's (PF) ability to control the aircraft by making inputs on the controls. The outcome was that all 150 passengers egressed the aircraft without injury, and that all 10 crew members escaped the aircraft. However, 8 cabin crew members sustained minor injuries.

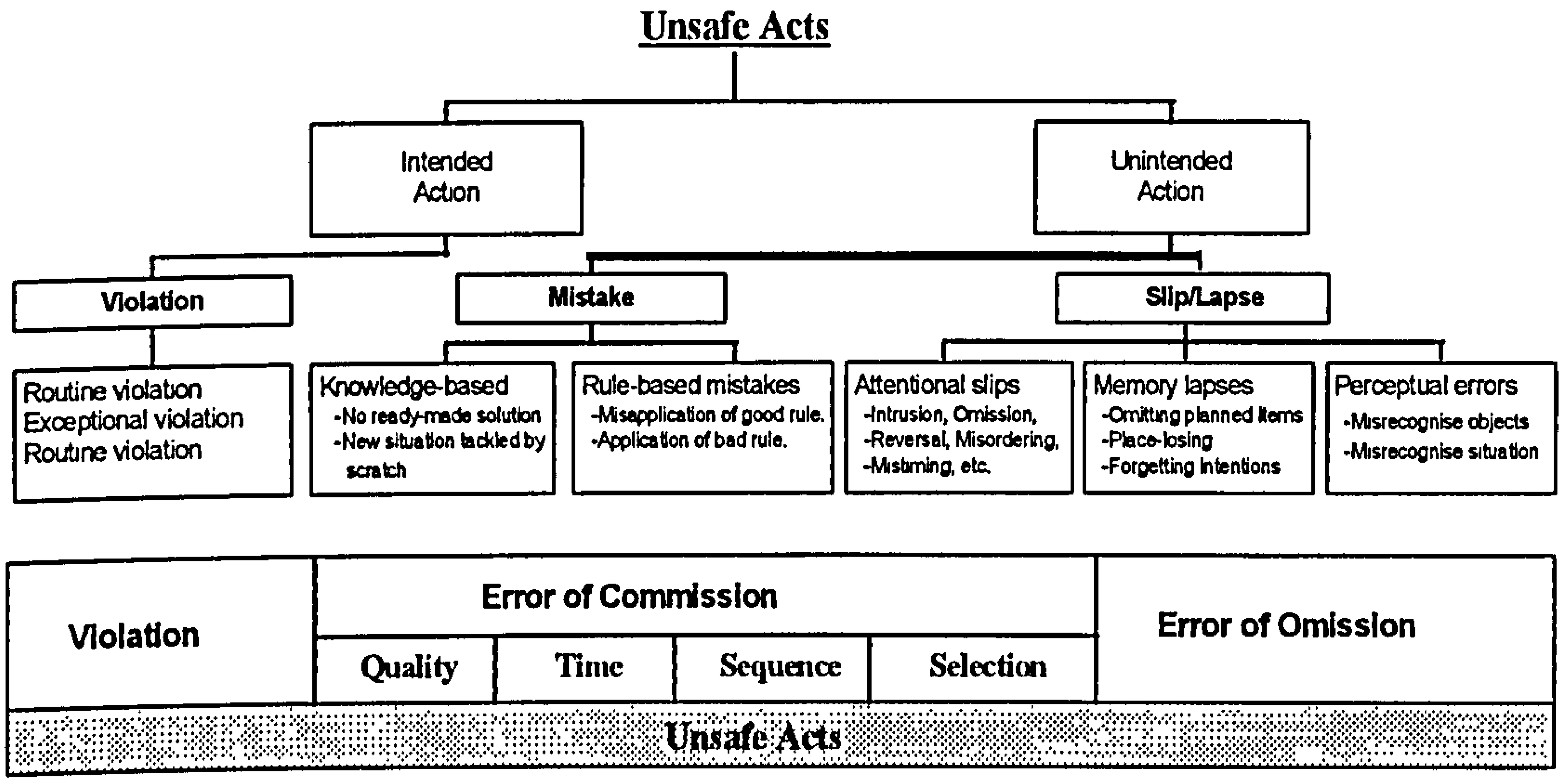



**Figure 3.3 A Summary of the Varieties of Unsafe Acts**

Besides the basic classification of human failures based on Rasmussen's performance levels, a more heuristic classification is used in the Technique for Human Error Rate Prediction (THERP). In its data base, unsafe acts are classified into the following taxonomy:

- Errors of Omission: Failures to perform actions to maintain the defences, such as act or step omitted, failing to start emergency equipment, a failure to carry out the required action or entire task. For instance, on 19th June 1988 at Delhi, India, a Boeing 737-200 made a normal, straight-in visual approach in VMC weather but landed with all landing gear retracted. The crew subsequently admitted pulling the gear warning circuit breaker and omitting portions of the landing checklist.

- Errors of Commission: Actions that cause or exacerbate the abnormal event, such as initiating a sequence of events/incidents, act carried out inadequately, act carried out in wrong sequence, act carried out at the wrong time (too early or too late), error of quality as too little or too much.

  - Selection error (selects wrong control, misposition control, issue wrong command)

  - Sequence error (action carried out in wrong order)

- Time error (too early or too late)
- Qualitative error (too little or too much)

- Violations: Unrequired actions carried out instead of, or in addition to, what is required. On the 2nd June 1983, a Fokker 28 ran off the end of the runway following a rejected takeoff refusal at Tanjung Karang, South Sumatrera, Indonesia. The reason for the takeoff aborted was that the crew did not follow the checklist, leaving the elevator trim at 1 unit nose down, which caused elevator control forces to be excessively heavy during rotation (Fokker, 1984).

### 3.1.2 The last cause of aircraft accident: Pilot factor

Active failures are unsafe acts associated with the performance of those in direct contact with the system. Usually, pilots are at the sharp end of the aviation system. Statistics clearly suggest that among human failures, pilot error accounts for the majority of accidents, and that the repeated finding of pilot factors as being the cause of accidents seems to have little effect on the prevention of future accidents.

In some parts of world, the focus of accident investigations has too often been on apportioning the possible cause to those closest to the accident, especially when everything else has been ruled out except for the pilot. Even though slips, lapses and mistakes are found to explain the unsafe acts which might trigger the accident, little is done to explain how and why these errors occur. The real question, however, is whether the root causes are actually initiated by pilots - the front-line operators or whether they stem from wider considerations.

Unlike technological causes of accident, pilot factor causes are not apt to be proved scientifically. They are often based upon conjecture and speculation, because pilot error seems to occur randomly and investigators have found it difficult to understand why these qualified and experienced pilots had difficulty coping with the circumstances leading to the accident. Hence, efforts to reduce or eliminate such random events may be ineffective. An alternative approach is to focus the accident prevention effort on investigating all aspects, that is, on determining the root causes rather than on locating the active causes. Additionally, the repetition of pilot errors also reveals that the safety system has failed to prevent a reoccurrence and suggests that these errors are more a symptom of a root cause, rather than the cause itself.

## 3.2 The Underlying Factor: Latent Failures

In considering the human contribution to accidents in large-scale, technically based systems and organisations[8], it is important to distinguish two kinds of failures: active and latent failures. Latent failures differ from active failures in a number of ways:

- Active failures are explicit; they have an immediate and direct impact upon the system. Latent failures, on the other hand, are implicit; they may lie dormant for long periods, only making their presence felt when they combine with active failures and local triggering events to breach the system's defences.

- Active failures are associated with the performance of 'front-line' operators: pilots, air traffic controllers, maintenance mechanics and the like. Latent failures, on the other hand, are generated by those at a higher level in the system: designers, high-level decision makers, operation managers, etc. These are people in the managerial and organisational spheres. In other words, active failures are related to individuals, whereas latent failures are associated with organisations.

- Whereas active failures are categorised according to their psychological /physical origins, latent failures are intimately bound up with the socio-technical systems.[9]

In the past, accident investigations often have not determined all the underlying causes of accidents. They focus essentially upon the primary causes of unsafe acts and unsafe conditions, such as active operator errors and equipment failures. When most causal factors are repeated over and over, and when the system has failed to prevent reoccurrence, it becomes, more often than not, a failure of the underlying system, e.g.

[8] Within the aviation system, organisations include airlines and other operators, manufacturers, airports, air traffic control, weather services, civil aviation authorities, safety investigation agencies, international organisations and professional associations .

[9] The term socio-technical systems, coined in 1960, refers to organisations which use high technology on a large scale. The aviation industry, nuclear power generations, marine and railroad transportation and the chemical processing industry are examples of socio-technical systems.

equipment design problems, poor operating procedures, communications failures, organisational deficiencies, personnel selection, training and scheduling problems, etc. Detailed analyses of recent accidents in technological systems have clearly indicated that these latent failures pose a greater threat to aviation safety than the active failures. Many of the root causes of the emergencies are usually present within the system long before usually active errors were committed, and these preconditions to accidents can be traced back to identifiable organisational deficiencies.

Reason (1993) puts it well, "individual errors at the sharp end are like mosquitoes. You can swat them, but there will still be plenty more to plague you. The only effective and long-lasting remedy is to drain the swamps in which they breed. In this case, the 'swamps' are unfriendly designs, conflicting goals, 'clumsy technology', and corporate cultures that do not learn from precursor incidents or share information effectively either internally or with related organisations."

In order to emphasise the significance and influence of the latent failures, Reason used the "resident pathogen" metaphor to describe the preconditions for accidents. Just as resident pathogens exist in the human body, latent failures are present in large-scale technological systems. Although their effects are not immediately apparent, they can promote active failures, weaken the system's defence mechanisms, and precipitate catastrophic failure once they have accumulated to a large extent and interact with trigger events.

Turner (1978) also points out that large-scale accidents have an "incubation period" in which a number of undesirable events that may contribute to an accident can lie unnoticed for years until a trigger event precipitates an accident.

Since the aviation industry involves high-hazard activities, the consequences of safety breakdowns are catastrophic in terms of loss of life and property. Safety efforts should attempt to discover and eliminate latent failures in the system, in addition to directing attention towards minimising and preventing active or front-line failures.

### 3.2.1 Accident recognition

From using their physical strength, employing natural resources, to developing technologies, human beings have been trying in various ways to optimise their use of energy for the purpose of improving their quality of life. However, if energy is not controlled or utilised correctly, it is likely to generate incidents or accidents. For instance, aircraft overrun the runway due to high approach speeds, car brake fail, nuclear energy are released accidentally, etc.

Before the beginning of industrial era, these incidents were recognised and explained as being Acts of God. As civilisation progresses, people gradually learn that incidents are caused by human error, engineering defects, or management deficiencies. From the remote past to the present, it has been a lengthy learning course.

Ever since the first aircraft accident occurred on 18 September 1908, causing the death of Lt. Thomas Selfridge, human factors has been playing an important role in accident events. Statistics from military and civil aviation also shows that more than sixty per cent of the aviation accidents involve human factors. Hence, one of the greatest challenges for aviation safety is to control and avoid human error. Traditionally, accident investigation confines itself to the unsafe acts of either pilots, maintenance personnel, or air traffic controllers. Nowadays, the scope of aviation safety has broadened to include managerial and organisational spheres. Detailed analysis of past significant event reports confirm that the root causes of many large-scale accidents were mostly initiated by bad decisions taken within the organisational and managerial domains (Wiener, 1993; Reason, 1990).

Close examination of past accidents indicates that many catastrophic events arise from the adverse conjunction of several distinct causal chains. Accidents like Tenerife, Three Mile Island, Chernobyl, and Challenger demonstrate the complexity of interactions between technology and people (Perrow, 1984; Fennell, 1988; Reason, 1990). Thus, it is natural for complex, tightly-coupled systems to suffer unforeseeable socio-technical breakdowns. Accident investigations may search for both contributing human failures and organisational/managerial deficiencies. The purpose of such retrospective searching should be to find out how and why the accidents occurred rather than who caused the accident.

### 3.2.2 Systematic approach to accident causation

As mentioned in the previous section, the investigation of aircraft accidents usually lays emphasis on tracing a plausible chain of causation in order to determine what unsafe acts triggered the event, instead of finding out why these human factors were associated with that accident. Following this approach, most accident prevention efforts concentrate on how to minimise and prevent the front-line unsafe acts. However, these unsafe acts not only seem to occur randomly but they also may previously have been repeating over and over without ill effect. Hence, the attempt to reduce or eliminate intermittent events has no effect on the prevention of future accidents.

Moreover, pilots in the aviation system are "the inheritors of system defects" rather than the main instigators of an accident. Pilots are selected and specially trained in the aviation system. Their actions and attitudes are a reflection of the circumstances surrounding them. In the broader perspective of the organisational and managerial domains, pilots should not be blamed for an accident or incident (unless they deliberately commit the error), as it is natural for human beings to make technical errors or mistakes of judgement. Besides, an unsafe act is more than just an error or a violation - it is a triggering event provoking the pre-existing and often long-standing latent failures within a complex technology-based system. Pilots are the last frontier in accident prevention. That is, accidents happen at the time they fail to defend the system, whereas systematic deficiencies may occur days, months or years after an error was made. Though the occurrence of a man-made accident leads inevitably to a search for human culprits, aviation safety can be significantly improved by detecting and correcting situational factors - the organisational and managerial failures that facilitate the pilot error.

In 1990, James Reason proposed a theoretical framework of accident causation to illustrate how active failures and latent failures interact to produce accidents, and indicate where and how more effective remedial measures might be applied. He emphasises the significance of the insidious and often unforeseeable situation when the unsafe acts were committed. This latent situation contains many weaknesses at all levels of the aviation system, such as design deficiencies, policy problems, undue time pressure, maintenance inadequacy, miscommunication, poor training and scheduling, personal problems, etc. Accidents arise when the damaging but underlying weaknesses combine with local triggering events to breach the system's defences. David Beaty put it well (1991): "Modern aircraft accidents result from collective mistakes rather than individual errors." Accidents are defined by the triggering of events or unsafe acts, while the occurrence of the accidents are determined by the underlying situational context. Safety efforts, therefore, should focus on discovering and eliminating the latent weaknesses in the socio-technical system that precipitate and exacerbate triggering events or unsafe acts.

#### 3.2.2.1 Applying Reason's model to accident causation

The aviation industry is a complex socio-technical system, a system involving a high degree of interaction between technology and people. Because human factors have been analysed as the major root cause in the past accidents, the principal concern within the aviation system is with the human contribution to system accidents. Reason's framework may be a good way to explain accident causation in such a complex system. Figure 3.3 identifies the basic elements and presents them diagrammatically as aircraft, one behind the other. These elements are respectively decision makers, line management, preconditions, productive activities, and defences.

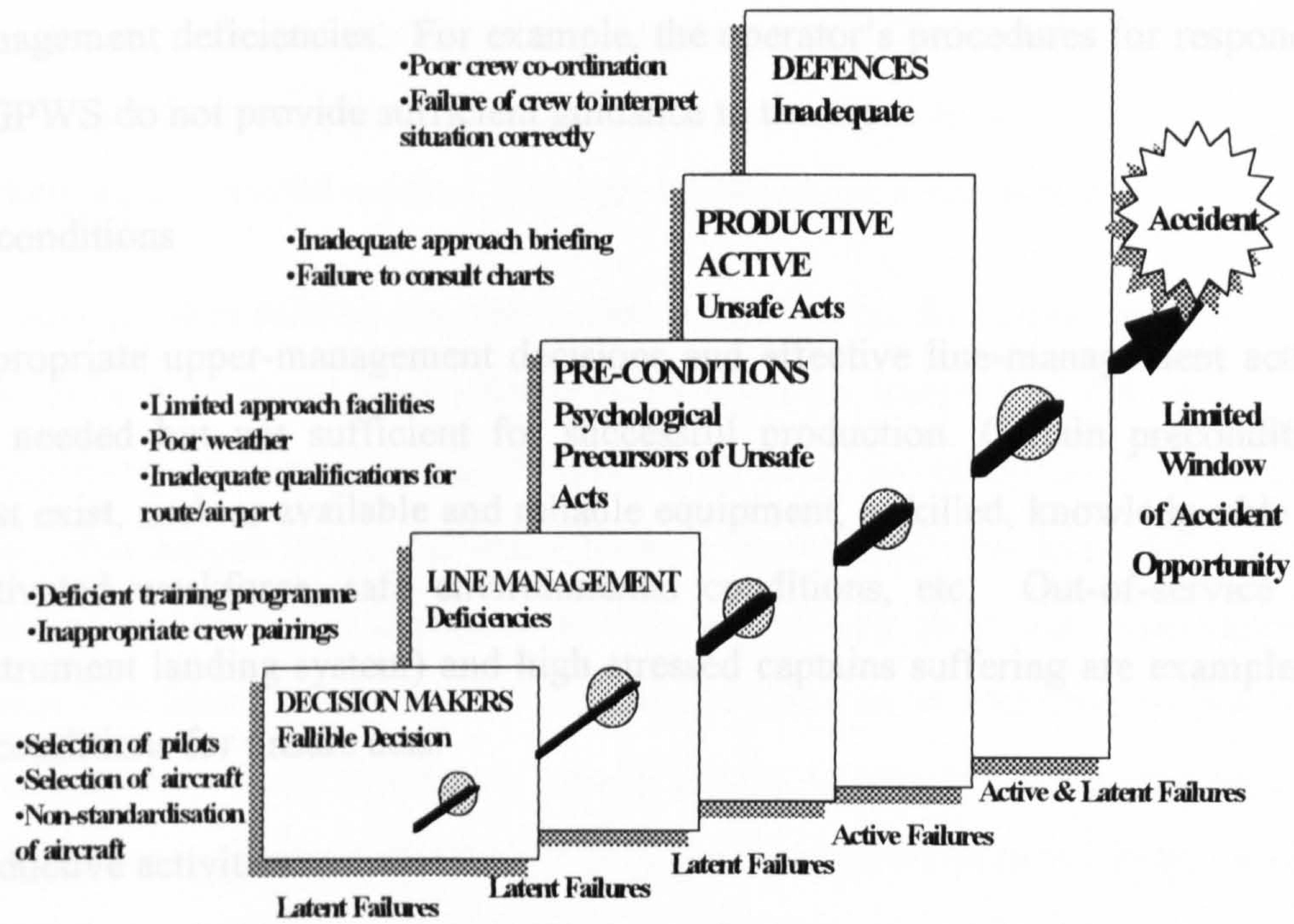



**Figure 3.4 Reason's Model: Human Contributions to the Breakdown of an Aviation System**

Source: Revised from J. Reason, 1990

1. The decision makers

   The decision makers include the manufacturer, airline top management and the civil regulatory authorities. Their aim is to survive competition and deploy available resources to maximise both on-time and cost-effective transportation as well as safety. Failures at this level are fallible decisions. For example, conducting flight crew simulator training for the Ground Proximity Warning System (GPWS) on an aircraft simulator differently equipped from the actual aircraft.

2. Line management

   Line management are responsible for implementing the strategies of the decision makers. They make sure that the line personnel execute and complete the decisions made by the upper management. Human failures in this element are management deficiencies. For example, the operator's procedures for responding to GPWS do not provide sufficient guidance to the crew.

3. Preconditions

   Appropriate upper-management decisions and effective line-management actions are needed but not sufficient for successful production. Certain preconditions must exist, such as available and reliable equipment, a skilled, knowledgeable and motivated workforce, safe environmental conditions, etc. Out-of-service ILS (instrument landing system) and high stressed captains suffering are examples of preconditions for unsafe acts.

4. Productive activities

   These are the integration of humans and machines. In the cockpit, they refer to pilot's performance when operating the aircraft. Underestimation of the danger posed by slippery runway conditions, late recognition of auto brake unintentionally being turned off and lack of positive, timely brake application exemplify unsafe acts in this element.

5. Defences

   Defences are safeguards against injury, damage, or costly interruptions of service in the event of some unsafe act being committed. For example, cases of inadequate defences include extremely poor inter-relationships and communication between the captain and the first officer, crew listening to the loudspeakers instead of using headsets, and co-pilot not passing all information to captain.

In aviation strict rules, high standards and sophisticated monitoring equipment are in place to protect against accidents happening. These excellent defence systems coupled with technological progress, mean that accidents rarely originate from single errors or isolated component failures. Instead, accident breakdowns arise from the interaction of a series of insidious failures within the managerial and organisational spheres. Many of these failures are not apparent, and their damaging consequences can lie dormant for a long time until they are triggered by external events. Also, they are unlikely to be detected unless a thorough investigation is conducted.

Reason distinguishes failures into two types, depending on the length of time it takes for these failures to reveal their adverse effect upon the integrity of the system. An active failure has an immediate and direct effect. These errors are usually committed by pilots, maintenance personnel and air traffic controllers. For example, a crew's response to the GPWS warning is not in accordance with the manufacturer's procedures. A latent failure refers to a fallible decision or incorrect action made before an accident. Such failures are usually present in a system for a long time and derive from those who are separated in both time and space from the event, such as decision makers, regulators, or line-management. Failures can be introduced at any level of the system by the human condition, e.g., airlines do not review present training policies with a view towards improving cockpit discipline and flying competency, civil aviation authorities do not review the adequacy of the operational supervision exercised by each airline, flight officer and flight engineer fail to follow the captain's instructions, crew alertness and mental concentration are affected due to jet-lag, emergency doors are not used, no evidence of the cabin crew's contribution to saving lives after a crash, etc.

Very few active or latent failures result in actual damage or injury if they occur individually; even though they will interact, they will rarely breach the defences of a well guarded system. However, latent failures can create 'windows of opportunity', loopholes in various layers of defences over time. On some occasions, a complex interaction between latent failures and a variety of local triggering events may occur. This can lead to one set of causal factors finding an appropriate trajectory to penetrate all of the defences and lead to the occurrence of an accident. Thus, the front-line operators may become the inheritors of all the system's defects. They are the ones that face the consequences when their actions, together with technical problems and adverse conditions reveal the latent failures present in the aviation system. In highly protected systems, a concurrence of active and latent failures may result in an incident; whereas in relatively unprotected systems, human actions interacting with the latent failures are likely to cause an accident. Here follows an example of how active and latent failures can interact to cause an accident.

At 1406 Yukon standard time, on the 23rd December 1983, Korean Air Lines (KAL) Flight 084, a scheduled cargo flight from Anchorage, Alaska, to Los Angeles, California, collided head-on with South Central Air (SCA) Flight 59, a scheduled commuter flight from Anchorage to Kenai, Alaska, on runway 6L-24R at Anchorage International Airport. Both flights had filed instrument flight rules flight plans, and instrument meteorological conditions prevailed at the time of the accident. The South Central Air Piper PA-31-350 was destroyed by the collision impact, and the Korean Air Lines McDonnell Douglas DC-10-30 was destroyed by impact and post-impact fire. Of the eight passengers aboard Flight 59, three were slightly injured. The pilot was not injured. The three crew members on Flight 084 sustained serious injuries.

The National Transportation Safety Board determines that *the probable causes of the accident were the failure of the pilot of Korean Air Lines Flight 084 to follow accepted procedures during taxi, which caused him to become disoriented while selecting the runway; the failure of the pilot to use the compass to confirm his position; and the decision of the pilot to take off when he was unsure that the aircraft was positioned on the correct runway.* Contributing to the accident was the fog, which reduced visibility to a point that the pilot could not ascertain his position visually and the control tower personnel could not assist the pilot. Also contributing to the accident was a lack of legible taxiway and runway signs at several intersections passed by Flight 084 while it was taxiing. (NTSB, 1984)

Detailed analysis of the accident shows how the conjunction of active and latent failures led to the event.

1. The decision of KAL 084's captain to use runway 32 for departure was not in accordance with KAL operating specifications (*unsafe act*). While the captain's decision did not directly bear on the accident since he attempted takeoff on a

runway other than the runway to which he was cleared, it was an operational deficiency and indicates performance not in keeping with that expected of an air carrier captain (*management deficiencies & decision makers*).

2. The flightcrew of KAL 084 did not cross-check their heading indicators to confirm their position (*unsafe act & inadequate defence*), not only because the KAL checklist did not require a pre-takeoff heading check (*management deficiency*), but also because the initial, or recurrent training the crew received or the operating procedures established for KAL crew members are deficient (*management deficiency*).

3. The restricted visibility, due to the heavy ice fog (*poor pre-condition*) and a lack of legible taxiway and runway signs at several intersections (*poor pre-condition*), caused the flightcrew of KAL 084 to experience difficulties while operating on taxiways and runways and adversely affected their operational performance (*unsafe act*). Besides, the airport was not equipped with ASDE (Airport Surface Detection Equipment), so that ground controllers could not assist the aircraft crew members by providing information on their location (*poor pre-condition*).

4. The captain failed to exercise proper decision-making responsibility by relying too heavily on the first officer's belief that the aircraft was on the correct runway. In this instance, the crew concept broke down because the flightcrews were not being adequately trained in managing cockpit resources, and co-ordinating their responsibilities when operating in marginal ground manoeuvring conditions that require intense concentration (*inadequate defence & management inadequacy*).

5. Based on the estimated takeoff gross weight of KAL 084, the runway length required for takeoff was 8,150 feet. Since the actual length available to KAL 084 on runway 24R was about 2,400, an accident would have resulted even if KAL 084 had not collided with SCA 59. (*Poor pre-condition*)

In brief, an accident is not solely the result of unsafe acts or unsafe conditions; the potential for an accident is created when human actions interact with other incorrect actions or fallible decisions that breach all the defences. The task of investigation is, therefore, not only to locate the unsafe acts made by the front-line personnel, but to determine why these actions are not caught by the system defences before causing damaging consequences. This requires identification of the related latent failures, from an operational level through to upper-management within the aviation system. Fortunately, most latent failures are revealed and identified by investigating incidents.

## 3.3 Importance of Incidents

### 3.3.1 Early recognition

Human beings have devoted their efforts towards improving technology in order to achieve greater aviation safety. In the aviation industry, radical changes and developments in technology have eliminated lots of hazards in hardware elements. As a consequence, the presence and magnitude of human error as a causal factor in accidents has come to light and been indelibly impressed on those who are responsible for minimising the risks associated with aviation operations.

As early as 1958, William A. Patterson, the President of United Airlines, mentioned the need for accurate safety-trend-information during a testimony before the US Senate. In 1966, Bobbie R. Allen, the Director of the US Civil Aeronautics Board, emphasised the importance of accumulating aviation safety incident information.

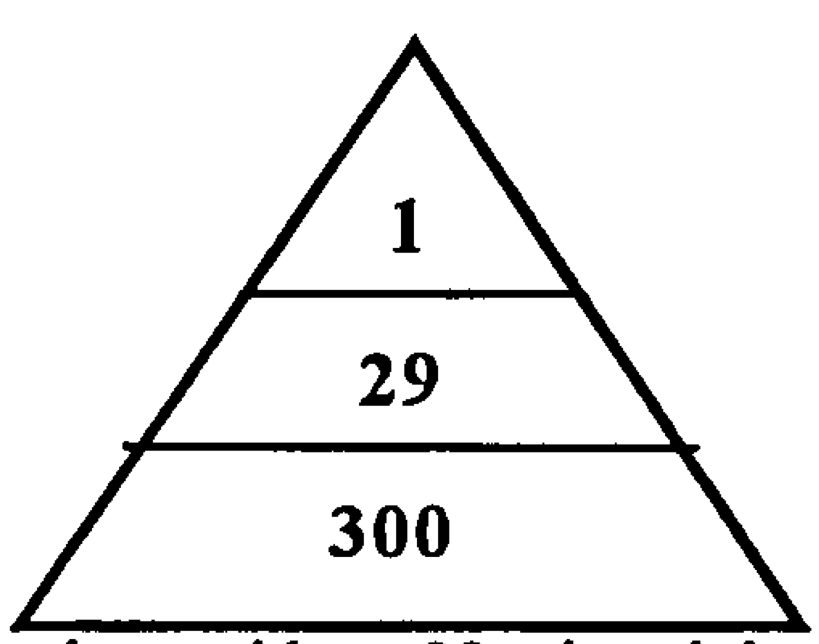
### 3.3.2 Potential disincentives for incident investigation

The lack of retrieval technology and the non-fatal or low-damage characteristics of incidents might appear to make incident investigation unnecessary or not worthwhile. Additionally, government regulations may use injury levels or dollar value of damage suffered to determine if an event calls for an investigation. As mentioned in Chapter 2, the dollar value and the level of injuries are still the determining factors for instigating reporting and the investigation in many countries.

### 3.3.3 The shortcomings of using accident data

Safety investigators and researchers have successfully traced the chain of causation in accidents to determine the "what" of the event, but sometimes they are not as effective in explaining the "why" of the event. Accident analyses reveal that at least 92 per cent of all root causes are man-made (Reason, 1990). As a result, the why of an event very often needs to deal with a very large subject, human error. In aviation, human factors involve machines of growing complexity, producing ever greater difficulties in the investigation of human performance issues. In addition, the nature of accidents causes several problems when addressing human contribution their occurrence.

Firstly, accidents occur very seldomly and, thus, provide relatively little data for safety investigators and researchers to validate a safety hazard (see Figure 3.3). Secondly, pilots are often unable to be of much help even though they are usually at the scene of aircraft accidents. They either do not survive accidents or are not willing to share their experience due to the threat of legal and financial liability for the events. Thirdly, despite the existence of various kinds of data recorders and some very skilled and experienced investigation teams, it is unlikely to be certain that all the causal factors have been discovered, and that the chain of causation determined by reasoning process precisely reflect actual situation. Even when the truth is disclosed, too often it has been the case that remedial action has been directed at the symptoms rather than the cause.




1 major accident, 29 minor injuries
300 no injury incidents (Source: Heinrich, 1950)

**Figure 3.5 Accident / Incident Ratio**

As accident investigation is a "post hoc" reasoning process, safety investigators must rely on factual findings to explore and determine the most likely causation. Inaccurate and unreliable information is particularly likely to be human errors.

It is universally accepted that before every accident there will have been incidents, or precursors of the accident. If detected and reminded early enough, these incidents will not have the potential to result in an accident. The precondition for taking appropriate preventive action is, therefore, to recognise these indications before they breach the system.

### 3.3.4 The characteristics of incidents

Prevention actions can start with small improvements in the everyday processes involved in air transportation, as their effect on aviation safety is far from small. The involvement of individuals working in air transport design, operations, and support may form a means to ensure comprehensive implementation of prevention strategies. In addition, the more feedback personnel offer, the more opportunity there is for pragmatic improvements to be promoted.

Few accidents will occur if humans learn from incidents. Hence, a highly effective means of accident prevention is to report, investigate and analyse incidents.

The most important characteristics of incidents are:

1. They can reveal the same hazards as accidents, but their extent of severity is not as heightened as those of accidents (see figure 3.4). That is, they lack the terminal event which causes the injury or damage in an accident.

2. Incidents outnumber accidents, so they provide more data for analysis and investigation.

3. Additional information is available from the people involved in incidents. Pilots and crew members survive incidents and, with the assurances of protection, they are more willing to share their experience.

4. The majority of incidents do not result in serious damage, so there is no threat of adverse legal or financial consequences.

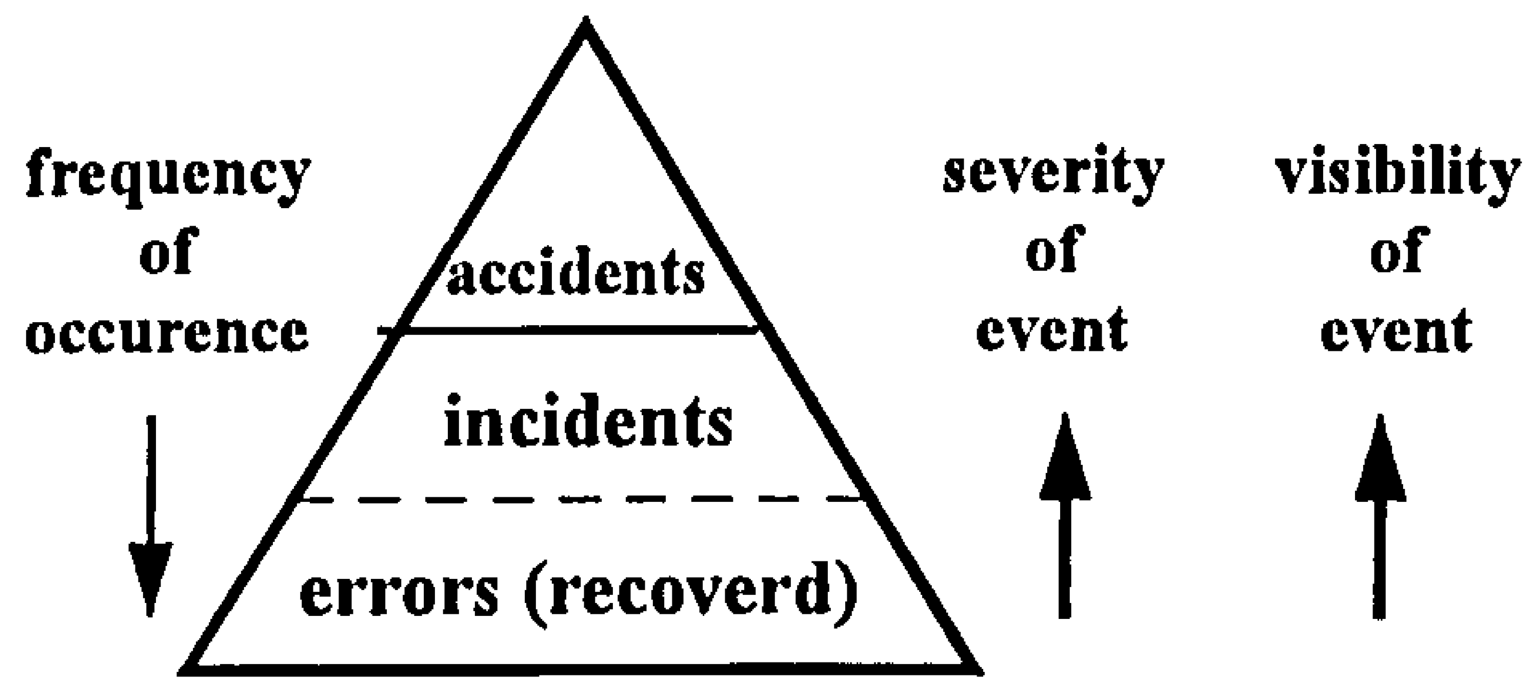



**Figure 3.6 The Relationship Between Accidents, Incidents & Errors**

### 3.3.5 Investigation of incidents

The decision to call for an investigation often depends on the severity of the outcome of the event. In other words, an investigation will be more likely to be ordered if there is significant loss of life or property. In some less serious events, however, the underlying causal factors may be just as hazardous and meaningful. Judging on the basis of potential to lead to accidents and the possible effectiveness of remedial measures, safety investigators and researchers should treat incident investigation at least as importantly and urgently as accident investigation.

Most accidents originate as a result of unintended actions committed by technically competent individuals who were merely doing their duties. They might have committed these same unsafe acts before without ill effect because the existing conditions at that time did not trigger the latent failures in the system. Under different circumstances, committing of unsafe acts might result in different consequences; some might result only in less serious incidents, while others might lead to severe loss.

Many incidents occur each day, most of which may appear too trivial to report to an investigatory authority, but which may have the potential for being accidents. Incidents are unlikely to be investigated on the basis of the magnitude of loss, but detailed analysis of incident data can often reveal the latent failures in the system and provide a significant insight into accident prevention.

The investigation of aviation accidents is a process of systematic reasoning. It is a continuous, selective and analytical process to validate safety deficiencies in human performance. Although investigators are seldom human factors specialists, they learn to continuously formulate significant events to make reasonable inferences. They selectively determine what particular human factors condition influenced the sequence of events leading to the occurrence, and analytically draw conclusion on the basis of empirical knowledge and verifiable evidence. Therefore, the more evidence that is accumulated, the more meaningful and supportable conclusions can be drawn. The essential task of finding causal and contributory factors is to explain how they were initiated and why they were not prevented before the mishap rather than to find out who was to blame. In short, its purpose is to prevent accidents. If the analysis and conclusions can not contribute to recurrence prevention, the investigation is meaningless.

### 3.3.6 First utilisation of incident data

In 1947, Fitts and Jones' pioneer work in developing the "critical incident technique" helps to establish the value of investigating incidents (Nagel, 1988). They used interview and written surveys to examine errors made by hundreds of crew members in utilising cockpit controls and instruments. The research pointed out that a total of 270 errors were made by pilots in reading and interpreting flight instruments (Degani and Wiener, 1991), as shown in Table 3.2.

**Table 3.2 Pilot Error in Utilising Cockpit Controls & Instruments**

| Display-related errors | Control-related errors |
|---|---|
| Incorrect interpretation | Control substitution |
| Legibility problems | Adjustment errors |
| Substitution errors | Memory errors control reversals |
| Undetected failures | Unintentional activation |
| Illusions, disorientation | Anthropometry-related errors |
| Failures to monitor | |

19 reversal errors in angle of bank were made by the pilots, when they used the moving horizon attitude indicator to correct an undesirable bank angle. Though these errors occur in relatively small numbers, they may result in serious outcomes, especially under circumstances when a pilot is disoriented or the aircraft is in a spiralling descent.

Fitts and Jones' research not only validated many ergonomic concepts which had been previously demonstrated only in laboratory research, but also systematically showed the significance of poor human engineering in incident generation and accident causation.

### 3.3.7 Incidents lead to accidents

The purpose of incident reporting is to transform the context of accident investigation from "incidents lead to accidents" to "reporting incidents prevent accidents". The following two cases are the examples of "incidents lead to accidents".

United Airlines incident and Trans World Airlines Boeing 727-231 accident

At 1110, East Standard Time, on the 1st of December 1974, Trans World Airlines (TWA), Inc., Flight 514, a Boeing 727, crashed 25 nautical miles north-west of Washington-Dulles airport, Washington D.C. The accident occurred while the flight was descending for a VOR/DME approach to runway 12 at Dulles during instrument meteorological conditions. The 92 occupants (85 passengers and 7 crew members) were killed and the aircraft was destroyed. Investigators found out that the aircraft descended below the minimum safe altitude.

The National Transportation Safety Board determined that the probable cause of the accident was the crew's decision to descent to 1,800 feet before the aircraft had reached the approach segment where that minimum altitude applied. *The crew's decision to descend was a result of inadequacies and lack of clarity in the air traffic control procedures which led to a misunderstanding on the part of the pilots and of the controllers regarding each other's responsibilities during operations in terminal areas under instrument meteorological conditions. Nevertheless, the examination of the plan view of the approach chart should have disclosed to the captain that a minimum altitude of 1,800 feet was not a safe altitude.* (NTSB, 1975)

In fact, about six weeks earlier, a United Airlines flight encountered the same situation at about the same place during the same approach procedure but was lucky enough to escape the lethal trap. The crew reported immediately to United Airlines' internal reporting system: the "Flight Safety Awareness Program".[10] After

[10] In January 1974, an air carrier in the United States initiated a Flight Safety Awareness Program. The purpose of the program was to encourage the carrier's pilots to report to the company any incident, or any suggestion, that could have safety implications, so that required remedial action could be taken. Under this program, an individual could make a report without identifying himself or his fellow crewmembers. The pilots were assured that the carrier would not take any punitive action as a result of information procured through this

investigating this incident and informing FAA at the Dulles tower, the carrier published a notice to all flight crews and informed them of the dangerous characteristics of flying this particular approach. In the course of the investigation of the TWA accident, the NTSB discovered that FAA had no formal system enabling such important information to be widely and urgently disseminated.

The probable cause of the accident was the crew's decision to descend below the minimum safe altitude. However, the failure of the FAA to take timely action to resolve the confusion and misinterpretation of air traffic terminology, although the problem had been aware for several years, apparently contributed to the occurrence of the accident. If the warning had been spread to other operators flying to Dulles airport, and if there had been a formal reporting program enabling pilots and controllers to report operational incidents, the accident might not have occurred.

Interflug Airbus A-310 incident and China Airlines A300-600R accident

At about 1050 local time on the 11th of February 1991, the former East German airline Interflug A310 D-AOHC while conducting an approach to Moscow's Sheremetyevo airport runway 25L initiated a go-around after being requested to do so by Sheremetyevo tower.

The A310 crew was on autopilot approach to Moscow and the crew pressed the go-around buttons because of an obstructed runway. Air traffic control wanted them to remain at pattern altitude, below the go-around altitude selected in the autopilot, so the crew turned the autopilot off to manually obtain the desired altitude.

But the autopilot was not off and it applied trim to continue the go-ground. As the aircraft climbed through 1,500 ft, the control column force resulted in disconnection of the autopilot, with the aircraft grossly out of trim. This led to five cycles of pitch excursions, up to 88 degrees and in amplitude the speed decreasing to 30 kt. At

program. The carrier would not voluntarily divulge information secured in this program to any outside agency which would permit identification of any individual involved. The carrier undertook to protect vigorously individual anonymity unless this protection was waived by the individual involved.

times, a recovery was made after a six-minute period, once thrust was reduced (AAIC, 1996).

After investigation of this complex sequence of events, Airbus Industrie published a (recommended) "cautionary operational advisory" regarding "Autopilot Override" in the Flight Crew Operating Manual (FCOM) for A300-600 and A310 in January 1991.

Here are excerpts from the Airbus Service Bulletin 6021:

> *"Autopilot Override" is a safety device required by the airworthiness authorities to allow the flight crews to regain control from the Autopilot in the event of Autopilot anomalies. Autopilot remains engaged but inactive except for the autotrim function. However, when override effort is released the Autopilot is reactivated.*
>
> The bulletin cites the *"approximate triggering threshold from a flight control neutral position expressed in loads to the control column, control wheels and pedals, all of which, experienced Airbus pilots said, are quite small."*

The following is quoted from the bulletin about the pitch axis:

> *Any action on the pitch trim control wheel disconnects the Autopilot with the autopilot in command, if the pilot counteracts the Autopilot (elevator order), the Autopilot will move the trim horizontal stabiliser (autotrim order) so as to maintain the aircraft on the scheduled flight path.*
>
> *Therefore, in pitch Go-Around (GA) mode, the following scenario might occur:*
>
> *During the GA procedure if the pilot immediately pushed the control column in order to limit the pitch up order, (after a few seconds) this situation would lead to a simultaneous inverse movement of the elevators (due to pilot action) and the stabiliser (due to autotrim orders).*

> *In such a configuration since the stabiliser efficiency is greater than that of the elevator, the aircraft could reach an abnormal pitch-up angle leading to an airspeed decay.*

Just a little more than three years later, at about 2016 local time on the 26th April 1994, at Nagoya, Japan, a China Airlines Airbus A300-600R[11] had an accident involving similar circumstances.

During the manually flown ILS approach at Nagoya, the go-around mode was inadvertently activated. In an apparent attempt to continue the approach, the autothrottles were disengaged, the throttles were retarded, both autopilots were engaged, and the copilot made a progressive nose down input to the elevators.

These actions overrode the autopilot go-around commands, drove the stabiliser trim to the full nose-up position, and caused the speed to decrease. The autopilots were disconnected, and the Captain decided to go-around. Unfortunately, a maximum nose down elevator input could not compensate for the combined pitch-up effects of full nose-up stabiliser trim and high thrust. The pitch attitude increased to 52° nose-up and the aircraft entered into a stall and crashed.

The final report from Japan's Aircraft Accident Investigation Committee determined that one of the factors causing the accident was (AAIC, 1996):

> "the aircraft manufacturer did not categorise the SB (Service Bulletin) A300-22-6021 as 'Mandatory', which would have given it the highest priority. The airworthiness authority of the nation of design and manufacture did not issue promptly an airwothiness directive pertaining to implementation of the above SB."

[11] China Airlines Airbus Industrie A300 took off from Taipei International Airport at 1753 local time on the 26th April 1994 and continued flying according to its flight plan. About 2016 local time, while approaching Nagoya Airport for landing, the aircraft crashed into the landing zone close to taxiway of the airport. On board the aircraft were 271 persons: 256 passengers (including 2 infants) and 15 crew members, of whom 264 persons (249 passengers including 2 infants and 15 crew members) were killed and 7 passengers were seriously injured. The aircraft ignited, and was destroyed.

If aircraft manufacturers[12], airlines and aviation regulation authorities had been more concerned with the incident of the Interflug Airbus A310 or the previous similar incidents (1st of March 1989 A300-600; 9th of January 1989 A300B4-203FF), as well as with safety information sharing and dissemination, the China Airline accident might have been prevented.

[12] On the 13th December 1994, Airbus Service Bulletin 6021 was revised from "Recommended" to "Mandatory".

### 3.3.8 Risk management loop

Operational feedback obtained through the operator's internal safety information system is of importance for upper- or middle- management to effect the control of operations that policies and procedures support. Figure 3.7 portrays the four feedback loops constituting the safety information system. Loop 1 feeds back information from accident rescue and investigation. In most cases, the information is too little and too late for safety management to effectively eliminate the hazardous factors that have already occurred. The only function of the feedback is to reduce the severity of property damage and life loss. Loops 2 and 3 carry information about the unsafe acts, unsafe conditions or incidents observed in daily operations. As in the tip of an iceberg, these unsafe acts, unsafe conditions or incidents will probably result in significant accidents though at first they may not be recognised and may not have immediate ill effects. Since such information is usually disseminated at lower levels, it is likely to be ignored over time and cause accidents if left untreated. All loops provide the opportunity to improve safety; so-called risk management, for they allow management to assess the level of operational risks and to determine the best prevention approach. The basic function of incident reports is accident prevention because the feedback obtained offers upper management timely information to react effectively and modify the company's policy and procedures appropriately.

As the majority of aviation incidents, no matter whether they occur often or occasionally, do not cause serious damage or loss, most carriers do not think they are worth reporting and pilots, also, are unwilling to have them publicised. Further understanding and investigation are consequently rare. Under these circumstances, civil regulatory authorities and airlines cannot under emphasise their importance, since the investigation of an incident arguably provides better accident prevention results than an investigation of an accident, in terms of frequency and severity.

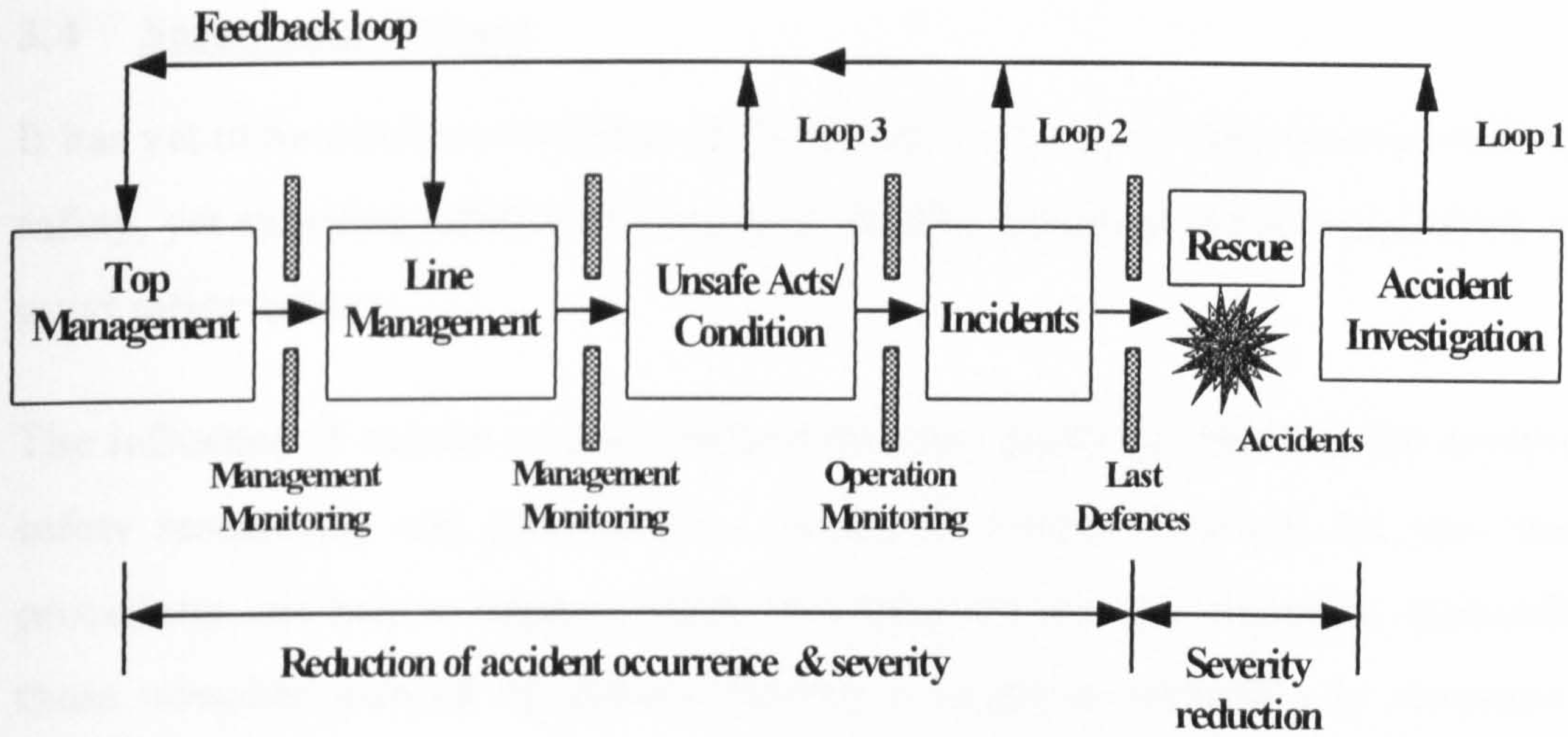



**Figure 3.7 Risk Management Loop**
Source: Adapted from Reason, 1990

In order to learn the right lessons from incidents, a safety management system should clarify the processes for identifying and evaluating potential hazards, for following-up incidents and for communicating safety-related matters.

## 3.4 Safety and Culture

It has yet to be confirmed whether an important connection exists between culture and safety, yet excellent safety performance is usually witnessed in an organisation with a good safety culture.

The influence of culture on pilot performance has gradually attracted the attention of safety researchers and practitioners. Improved cockpit controls and new training procedures can help to improve safety, but these are not root remedies, especially for those mistakes induced by cultural factors. It might be necessary to scrutinise and modify the entire corporate culture of an airline, as this is what shapes pilot decision making, maintenance practices and other human elements of safety performance.

### 3.4.1 Cultural characteristics

The concept of safety culture referred to above is just one facet within the area of culture. The term "culture" originally comes from social anthropology and is defined broadly and variously. Basically, it is regarded as the collection of beliefs, values, norms, rituals, attitudes, roles and practices of a given group, organisation, institution or society. In its most general sense, culture refers to the shared patterns or style in a group that are difficult to change. It is about how people think, what they value and how they behave, these characteristics are present at a fundamental level, and yet people are often unaware of many of the values that bind them together.

### 3.4.2 Culture classification

There are many levels of culture, and each of these has a natural tendency to influence the other. At the broadest level, perhaps, is the national culture, that is the primary values and practises that characterise a particular country. There are also organisational and occupational cultures, relating to where one works and the kind of work one performs.

In most industrial situations, excellent performance is associated with strong organisational cultures because they create a surprising amount of consensus, which is usually valued by employees. Robbins (1989) described organisational culture as "a common perception held by the organisation's members; a system of shared meaning", and listed ten characteristics to explain the issue of organisational cultures. These are as follows:

- Individual initiative
- Direction
- Management support
- Identity
- Conflict tolerance
- Risk tolerance
- Integration
- Control
- Reward system
- Communication patterns

After examining British, French and German (as well as Arabic, Japanese and American) organisational cultures, Pugh (1988) argued that even though the context and the structure of an organisation may be the same, people behave differently in different cultures. This accords with Chute and Wiener's (1994) study, in which they conclude "despite sharing the same objectives, the flight deck and cabin crews have evolved into two distinct cultures with different perspectives and approaches." A reasonable corollary of this is that flight and ground crews might also have similar problems.

### 3.4.3 Difficulty of cultural transformation

An organisation's safety culture cannot be changed as quickly by management decree or legislative prescription as many had at first assumed; culture change involves a long-term process of organisational learning.

Culture, as referred to above, has two characteristics: visibility and resistance to change. Kotter et al (1992) found that "at the deeper and less visible level, culture refers to values that are shared by the people in a group and that tend to persist over time even when group membership changes; at the more visible level., culture represents the behaviour patterns or style of an organisation that new employees are automatically encouraged to follow by their fellow employees." (see figure 3.8)

Invisible | Harder to Change

*Shared Values*: Important concerns and goals that are shared by most of the people in a group that often persist over time even with changes in group memberships.
Examples: Operations managers are strongly involved in the safety events; Crews are willing to report hazards/incidents.

*Group Behaviour Norms*: Common or pervasive ways of acting that are found in a group and that persist because group members tend to behave in ways that teach these practices (as well as their shared values) to new members, rewarding those that fit in and sanctioning those that do not.
Examples: The awareness of safety is_good in the organisation; Flight and ground crews co-ordinate well in the organisation.

Visible | Easier to Change

**Figure 3.8 Culture in an Organisation**

Source: Revised from Kotter & Heskett,

Conceptualised in this way, culture in an organisation is not the same as a corporate's structure or strategy. However, these terms (and others such as "vision") are sometimes used almost interchangeably because they can all play an important part, along with the competitive and regulatory environment, in shaping people's behaviour (see Figure 3.9).

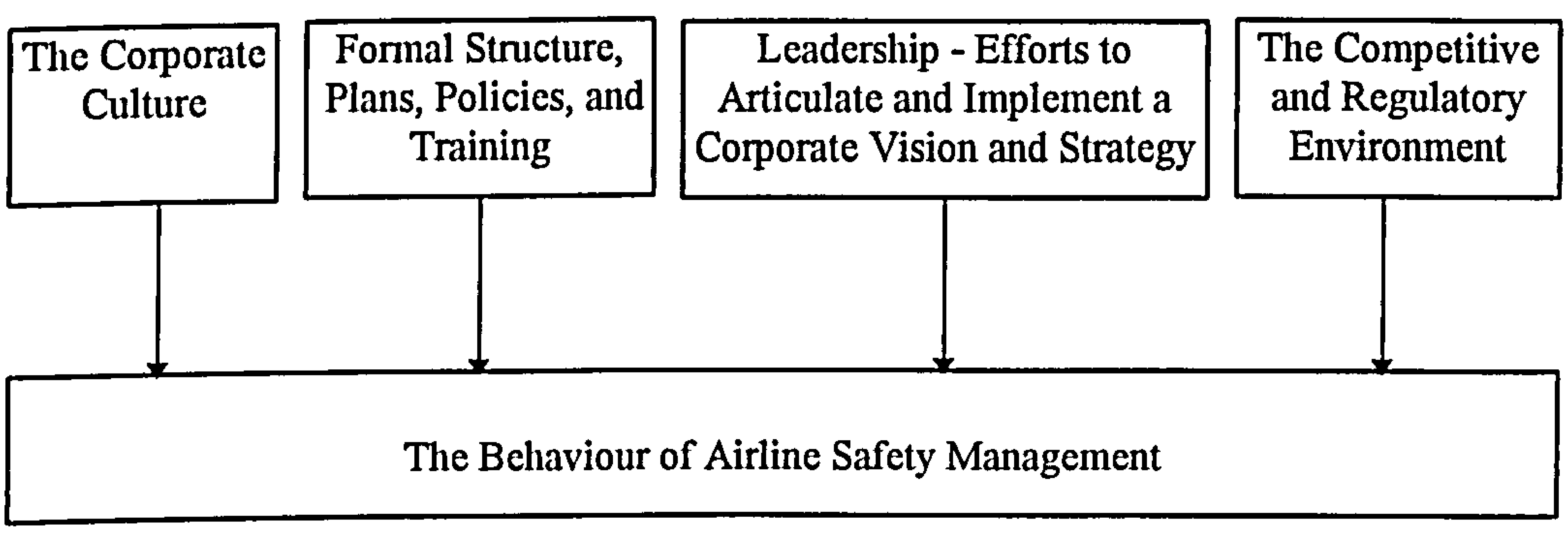



**Figure 3.9 Four Factors that Shape Airline Managerial Behaviour**

Other difficulties, such as what happens when cultures are congruent and in conflict, will be discussed in Chapter 5.

### 3.4.4 Characteristics of safety culture

#### 3.4.4.1 Development of safety culture

Traditional human factors approach to safety has changed in recent years. Increasingly, wider organisational factors have been considered significant in enhancing or undermining safety. The change derives in part from a number of prominent accidents[13] that occurred over the past decade, especially in the aftermath of Chernobyl. The Chernobyl accident was caused by a combination of poor reactor design and operator errors. Subsequently, the serious human errors and violations of procedures were interpreted as evidence of a poor safety culture. Accidents are, therefore, described as resulting from the breakdown of an organisation's safety culture.

The term 'safety culture' is initially characterised as the set of beliefs, norms, attitudes, roles, social and technical practices that are concerned with minimising the exposure of individuals to dangerous or injurious conditions.

A broader definition is provided below (Pidgeon, 1991):

> *Safety culture can be conceived of as the constructed system of meanings through which a given people or group understand the hazards of the world. Such a constructed meaning system specifies what is important and legitimate to them, and explains their relationship to matters of life and death, work and danger. A culture is created and recreated as members of it repeatedly behave in ways that seem to them to be the natural, obvious, and unquestionable ways of acting, and as such will serve to construct a particular version of risk, danger, and safety.*

---

[13] Examples of significant accidents, across a wide variety of large-scale hazardous systems, include: in nuclear power generation, the Chernobyl explosions (26th April 1986) ;in marine and railroad transportation, the King's Cross underground fire (18th November 1987) and the Zeebrugge ferry capsizing (6th March 1987); in the chemical processing industry, the Bhopal chemical disaster (2-3rd December 1984); and in aerospace, the Space Shuttle *Challenger* ( 28th January 1986).

Although the majority of the research work prompted by these events has been concerned with safety in contexts other than aviation, the hard lessons learned concerning the role of organisational factors and safety cannot be ignored by aviation practitioners.

Organisational causes of accidents are not a new phenomenon in aviation. They have been present since the earliest days of civilian and military aviation, but attention has been diverted away from them more immediately visible causes of accidents. However, it is now clear that many of the individual causes of accidents can be traced as resulting from deeply rooted deficiencies in the organisational and managerial domains surrounding the operations of the aircraft.

Turner was the first to identify unseen background preconditions to failures in socio-technical systems. His accident incubation period model focuses, in particular, upon information difficulties associated with the attempts of both individuals and organisations to deal with uncertain and ill-structured safety management problems (Pidgeon and O'Leary, 1994). Similar conclusions are drawn by other researchers in the area, who argue that large-scale accidents do not originate solely from individual failures, but from a chain of unanticipated interactions of technical, individual, managerial and organisational failures. The overall contribution of organisational and managerial aspects to accidents is often crucial and must be dealt with in order to enhance safety culture.

#### 3.4.4.2 A good safety culture

Understanding the nature of accident causation in socio-technical systems implies that safety improvement may be more desirable when efforts are expended in creating a good safety culture. The question now turns to what elements may characterise a "good" safety culture. Considering the culture/performance perspective, Pidgeon and O'Leary (1994) address four principle elements for aviation practice to enhance the development of a safety culture: location of responsibility for safety at strategic management level; distributed attitudes of care and concern throughout an organisation; appropriate norms and rules for handling hazards; and on-going reflection upon safety practice.

With respect to the accounts of accidents provided in the previous section, the first element emphasises that the responsibility for safety should move from an operational level toward a strategic management level. Top management commitment and involvement in safety will permeate through the entire organisation because employees will quickly sense where management's true priorities lie. Besides, the consequences of large-scale accidents require strategic planning and deployment from the top of the organisation to prevent their reoccurrence and to promote improved safety.

A further requirement for safe operations is distributed attitudes of care and concern throughout an organisation. Pidgeon (1991) points out that "safety attitudes refer to individual and collective beliefs about hazards and the importance of safety, together with the motivation to act on those beliefs." In other words, safety directives should be concentrated on caring for the outcome of how risks are dealt with and what effects they impose on people, so that organisation members will regard the policing of hazards more as a personal than a collective goal.

The third necessary condition is the establishment of appropriate norms and rules for handling hazards. Complete and up-to-date norms and rules should be created as guidelines for organisation members to guard against all anticipated hazards. Additionally, organisation members should constantly monitor normal procedures and operating conditions to detect any unexpected risks.

Ongoing reflexivity about current practices and beliefs is termed as Toft active learning. It is a process of reviewing accidents and acting accordingly to best guard against recurrence. In aviation, accident investigation as well as proactive incident reporting and feedback is found useful for locating unanticipated hazards. Open communication links between management and personnel, establishing a blame-free environment and giving priority to safety have also been found to be associated with safe climates in industrial organisations.

### 3.4.5 Transforming culture

Many of the considerations discussed above suggest that a good safety culture will not only promote safer practices throughout the entire organisation, but also that it is a crucial element for the development of an organisation over the long term. Even though organisations actively avoid laying blame for mistakes and errors, there is no guarantee that operational personnel are willing to conform to the change. There tends to be a marked disparity between operational personnel's perception of how the change would affect their workload and operations compared with the views held by upper management. The reasons for these differences are not easy to understand, but the possibilities considered are that:

- The culture in the workforce is resistant to change because employees are used to their old work habits and roles. They are unwilling or unable to leave the "comfort zone of competence" (Miller, 1992).
- The effects and benefits that the changes will bring to individuals and the organisation are not adequately presented or addressed during training.
- The effects or benefits presented are not accepted by operational personnel.

The human side of change, as Miller argues, is neither logical nor reasonable and can involve feelings of doubt and fear. Employees are afraid of giving up the traditional norms and ways of doing things and feel uncertain about the effects and benefits that new changes will bring. Unfortunately, employees' fear of change is perceived as unwarranted resistance to change by managers, which may result in employees' reluctant to share their feelings openly for fear of being viewed as troublemakers.

Rather than pushing harder to overcome resistance to change, artful managers may discern the source of the resistance by applying the following strategies (Ho, 1995):

- Emphasising needs for change and information about changes at all times.

- Providing transition training in new values and behaviour patterns.
- Building tangible symbols or targets in the new directions.
- Providing sufficient resource for the change process.
- Starting with small projects and building up continuously.
- Insisting on the importance of security in transition.
- Giving visible support to all those involved with the change.
- Being sensitive to those who are at different stages in acceptance of the change.
- Providing a safety net for when people make mistakes.

However, organisational cultures are resistant to change and recent attempts to manipulate corporate behaviour by changing organisational cultures have met with only limited success (Nord, 1985). Figure 3.10 shows the transformation of a human being in terms of difficulty levels and the time required to accomplish a change on the five levels: recognition, knowledge, attitudes, individual behaviour and group behaviour.

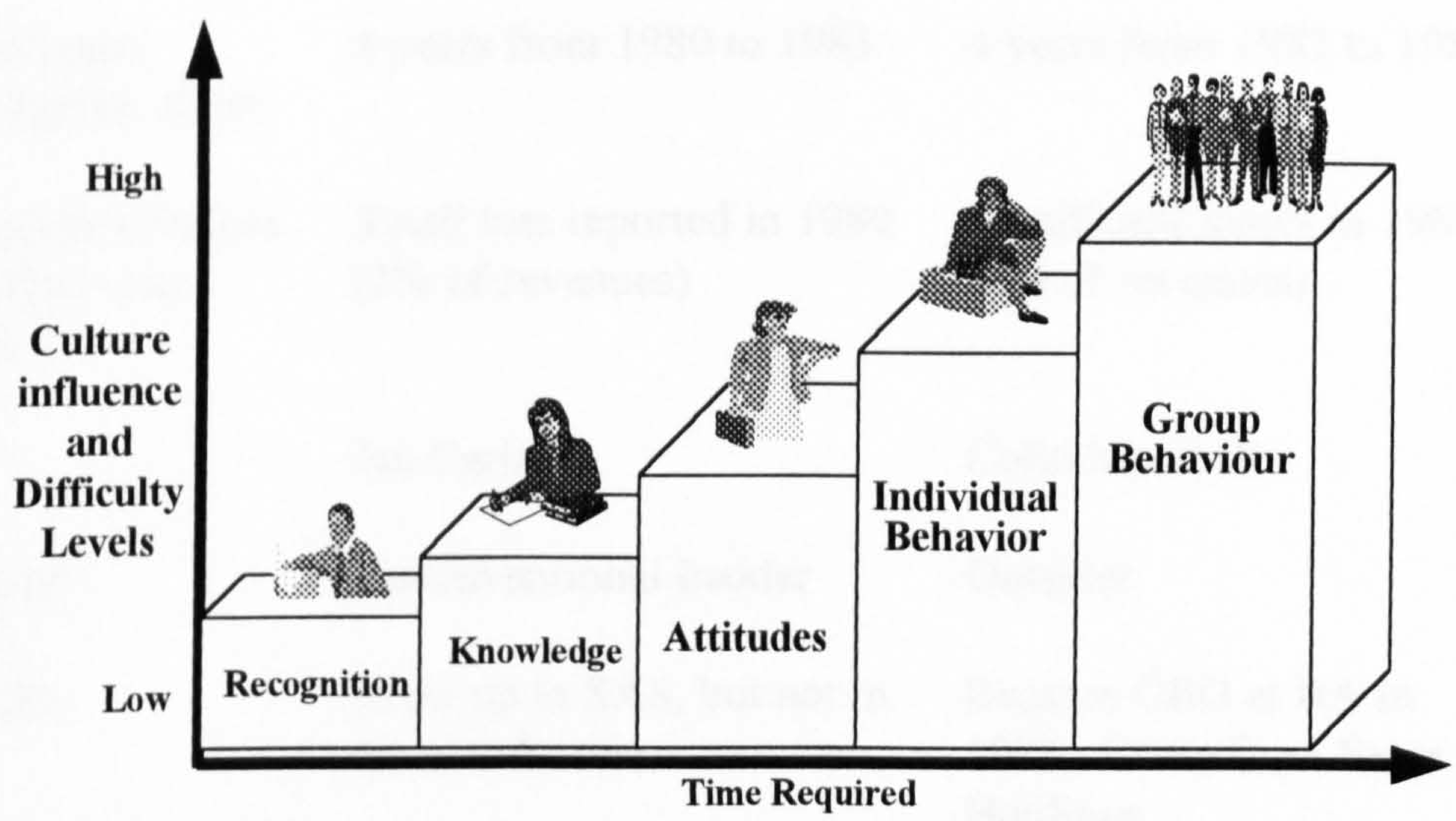



**Figure 3.10 Transformation of human being on five level**
Source: Adapted from Yamamori, 1993

The attainment of change in individuals takes time and is very difficult. It would take a much longer time and be more difficult for a group or an organisation to change its behaviour or culture.

The establishment of major cultural change appears to be rare but is feasible. The most visible factor in distinguishing major cultural changes that succeed from those that fail is competent leadership at the top. Successful leaders know how to implement new visions and new strategies for achieving those visions. They are good at persuading key individuals in the organisation to commit themselves to that new direction and then are able to energise the entire workforce to make the change happen, despite all the obstacles that may be present. In Europe, two competent CEOs have successfully implemented major cultural changes in BA (British Airways) and SAS (Scandinavian Airlines System). They spent four years in bringing about successful results. Table 3.3 shows the background of these leaders and the circumstances of the two companies before and after cultural change.

**Table 3.3 Two Successful Cases of Cultural Change**

| Company | Scandinavian Airlines | British Airways |
|---|---|---|
| Size of organisation | Medium | Large |
| Length of major cultural change effort | 4 years from 1980 to 1983 | 4 years from 1982 to 1985 |
| Losses reported before change effort was instituted | Small loss reported in 1980 (2% of revenues) | Significant losses in 1981 (7% of revenues) |
| Leader | Jan Carlzon | Colin Marshall |
| Background | Unconventional Insider | Outsider |
| Career path | Grew up in SAS, but not in the core business | Became CEO at BA in 1983. Came from Sears Holdings |

Source: Compiled from Kotter et al, 1992, pp. 91,93,95 & 105.

Even though leadership at the very top of an organisation seems to be an essential ingredient for major cultural change to occur, ongoing change is necessary for sustaining comparative advantage in a competitive environment. Permanent change is best addressed through, as Westrum (1987) advocates, establishing "generative" organisations, or what are more commonly called "learning organisations"[14] nowadays. This issue will be discussed in the next section.

[14] Peter Senge, who popularised learning organisations in his book The Fifth Discipline, described them as places "where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together."

## 3.5 Safety Culture and Incident Reporting

### 3.5.1 Learning occurred by openness

As philosopher George Santayana says, "Those who cannot remember the past are condemned to repeat it." The importance and value of past experience is beyond expression. Few companies, however, have established processes for their managers to review their successes and then failures and learn from their experiences.

Boeing's case, for example, explains how the knowledge gained from failures can be used to achieve subsequent success. Soon after encountering problems with the 737 and 747 plane programs, Boeing's senior managers commissioned a high-level employee group to examine the trouble products. The group produced hundreds of recommendations over a three year period, and the lessons gained in development of these earlier programmes helped to make the 757 and 767 the most "successful" jets in the company's history.

Learning from past experience is of key importance, but is certainly not the only factor to account for the success of Boeing. The willingness of managers to listen attentively and their openness to criticism enabled safety information to be transferred quickly and effectively throughout the company and made the progress far more likely. These contributing factors accord well with the generative features of safety management discussed in the above section.

### 3.5.2 Safety culture influences incident reporting

In an ideal world safety culture would enable line pilots to discuss their technical, operational, crew and personal problems directly with their managers through reporting systems. This ideal world would greatly benefit safe management in two ways: firstly, a greater volume and diversity of information could be acquired; and secondly, the information could lead to more accurate risk assessment and more thorough learning. In practice, safety culture in most large organisations is not robust enough to generate open communication links between management and personnel. In such organisations, the fear of blame and punishment can prevent reporters of unsafe events from exchanging safety information openly. As advocated above, pilots are the inheritors of the defective system. When an incident occurs, they are often forced to take the full responsibility for the event even if they operate the aircraft to the best of their ability. From the other viewpoint, pilots tend to have a strong pilot's ego, so it is difficult to ask them to report their unsafe acts. Thus, the pilots' unwillingness or unlikeness to report incidents without assurances of protection and confidentiality is not unreasonable. Moreover, pilots are likely to have misgivings about the undesirable consequences which incident reporting might bring upon themselves or other crew members. In such unfavourable circumstances, the organisational culture that surrounds pilots becomes an important factor in determining the success of a reporting system, no matter whether it is mandatory, voluntary or confidential. (Confidential reporting will be discussed in Chapters 6 & 7.)

Based on the nature of their communication culture, organisations can be placed into three different categories: generative, bureaucratic, and pathological (see Table 3.4). These categories reflect the kind of support that an individual might expect from upper management after his or her problems are reported.

**Table 3.4 Basic Communication Styles**

| PATHOLOGICAL | BUREAUCRATIC | GENERATIVE |
|---|---|---|
| Information is personal power | Information is routine | Information is seen as a key resource |
| Responsibility is shirked | Responsibility is compartmented | Responsibility is shared |
| Messengers are shot | Messengers are listened to if they arrive | Messengers are trained |
| (Departmental) bridging is discouraged | Bridging is tolerated | Bridging is rewarded |
| Failure is punished or covered up | Organisation is just and fair | Failure leads to inquiry / learning |
| New ideas are actively crushed | New ideas present problems | New ideas are welcomed |

Source: Westrum, 1993

In an ideal world, management would support and build a 'generative' culture within the organisation. The primary goal of a generative culture would be learning from mistakes, rather than apportioning blame and taking punitive action. In other words, forgiveness should be practised in the learning organisation. Real forgiveness, as Senge (1990) addresses, includes both 'forgive' and 'forget' - forgiving the one who made a mistake and forgetting there was ever a mistake. As Cray Research's CEO John Rollwagen says, "Making the mistake is punishment enough." Blame and punishment do not have any prevention value and they can often be counterproductive. There might be a social or psychological need but this need is meaningless in good risk management, which is essential in a high-technology, high risk aviation system. Neil Johnston (1994) argues that "Immediate failures on the part of an individual are thus irrelevant for all practical purposes, save for the identification of essential changes to the system. Feedback on the efficacy of system performance must be the primary focus - given that it is the principal means of controlling risk."

To err is human. The individual mistakes advanced above are the indicators of system failures. Pilots are specially selected and trained, and system failures are usually detected from the analysis of the feedback of on-line personnel. If management focuses on allocation of individual blame rather than the creation of a safety culture learning from past experience and locating root causes, no one will be willing to make incident reports.

## 3.6 Culture and Accident Rate

The social environment in which one grew up and collected one's life experiences influence one's patterns of thinking, feeling and unconscious behaviour. These patterns of thinking, feeling and acting are culture. As mentioned earlier, cultures differ according to nation (region, ethnic background, religion and language), age, gender, social class and organisation. Pilots unavoidably carry several layers of culture and this deeply-rooted mental programming leads them to think and act differently in the cockpit. A frequent problem is that these various levels of culture are not always in harmony. Pilots' behaviour will be difficult to anticipate when these mental programs are in conflict.

In aviation, understanding the differences in thinking, feeling and acting in people from around the globe is more likely to bring about solutions to help prevent accidents than improving mutual understanding among multi-national crews at a lower level.

### 3.6.1 Hofstede's four measures of national cultures

After conducting a systematic study of work-related values across more than 50 countries, Geert Hofstede found that these subjects in different countries revealed common problems, but with solutions differing from country to country in four areas analysed- social inequality, the relationship between the individual and the group, concepts of masculinity and femininity, and ways of dealing with uncertainty. The empirical results correspond to the common basic problem areas found in Inkeles and Levinson's study 20 years ago.[15] Hofstede uses four dimensions of culture to represent the four basic problem areas. They are given the names Power Distance (PDI), Uncertainty Avoidance (UAI), Individualism (IDV), and Masculinity (MAS). Countries, thus, can be scaled and differentiated across the four basic dimensions. In

[15] In 1954 the sociologist Alex Inkeles and the psychologist Daniel Levinson published a broad survey of the English-language literature on national culture, and discovered common problems world-wide in the following areas: 1) Relation to authority, 2) conception of self, in particular about the relationship between individual and society, and the individual's concept of masculinity and femininity, and 3) ways of dealing with conflicts, including the control of aggression and the expression of feelings. (Inkeles and Levinson, 1969)

the Hofstede study, more than 50 countries, on the basis of their four-dimensional scores (see table 3.4), were sorted into 13 clusters. That is because each country will share some characteristics of its culture with another country. For example, Taiwan, Korea, Japan are three different countries, but all of them are influenced by the Confucius culture.

**Table 3.4 Values of PDI, UAI, IDV, and MAS Indices for 50 Countries and 3 Regions[a]**

| Country | PDI | UAI | IDV | MAS | Country | PDI | UAI | IDV | MAS |
|---|---|---|---|---|---|---|---|---|---|
| Arab* | 80 | 68 | 38 | 53 | Jamaica | 45 | 13 | 39 | 68 |
| Argentina | 49 | 86 | 46 | 56 | Japan | 54 | 92 | 46 | 95 |
| Australia | 36 | 51 | 90 | 61 | Korea (South) | 60 | 85 | 18 | 39 |
| Austria | 11 | 70 | 55 | 79 | Malaysia | 104 | 36 | 26 | 50 |
| Belgium | 65 | 94 | 75 | 54 | Mexico | 81 | 82 | 30 | 69 |
| Brazil | 69 | 76 | 38 | 49 | Netherlands | 38 | 53 | 80 | 14 |
| Canada | 39 | 48 | 80 | 52 | Norway | 31 | 50 | 69 | 8 |
| Chile | 63 | 86 | 23 | 28 | New Zealand | 22 | 49 | 79 | 58 |
| Colombia | 67 | 80 | 13 | 64 | Pakistan | 55 | 70 | 14 | 50 |
| Costa Rica | 35 | 86 | 15 | 21 | Panama | 95 | 86 | 11 | 44 |
| Denmark | 18 | 23 | 74 | 16 | Peru | 64 | 87 | 16 | 42 |
| East Africa** | 64 | 52 | 27 | 41 | Philippines | 94 | 44 | 32 | 64 |
| Ecuador | 78 | 67 | 8 | 63 | Portugal | 63 | 104 | 27 | 31 |
| El Salvador | 66 | 94 | 19 | 40 | South Africa | 49 | 49 | 65 | 63 |
| Finland | 33 | 59 | 63 | 26 | Singapore | 8 | 74 | 20 | 48 |
| France | 68 | 86 | 71 | 43 | Spain | 57 | 86 | 51 | 42 |
| Great Britain | 35 | 35 | 89 | 66 | Sweden | 31 | 29 | 71 | 5 |
| Germany (West) | 35 | 65 | 67 | 66 | Switzerland | 34 | 58 | 68 | 70 |
| Greece | 60 | 112 | 35 | 57 | Taiwan | 58 | 69 | 17 | 45 |
| Guatemala | 95 | 101 | 6 | 37 | Thailand | 64 | 74 | 20 | 34 |
| Hong Kong | 68 | 29 | 25 | 57 | Turkey | 66 | 85 | 37 | 45 |
| Indonesia | 78 | 48 | 14 | 46 | Uruguay | 61 | 100 | 36 | 38 |
| India | 77 | 40 | 48 | 56 | USA | 40 | 46 | 91 | 62 |
| Iran | 58 | 59 | 41 | 43 | Venezuela | 81 | 76 | 12 | 73 |
| Ireland | 28 | 35 | 70 | 68 | West Africa*** | 77 | 54 | 20 | 46 |
| Israel | 13 | 81 | 54 | 47 | Yugoslavia | 76 | 88 | 27 | 21 |
| Italy | 50 | 75 | 76 | 70 | | | | | |

[a] Key to *Indices* - PDI, Power distance; UAI, Uncertainty avoidance; IDV, Individualism; MAS, Masculinity. *Regions* - *Arab: Egypt, Iraq, Kuwait, Lebanon, Libya, Saudi Arabia, U.A.E.; **East Africa: Ethiopia, Kenya, Tanzania, Zambia; ***West Africa: Ghana, Nigeria, Sierra Leone.

The four dimensions are very similar to the ten characteristics of organisational culture listed by Robbins (1989). For example, the characteristics of individual initiative, management support and identity could all be items concerned with the individualism / collectivism dimension of Hofstede, whereas the risk tolerance, control, and conflict tolerance could all be items concerned with the uncertainty avoidance dimension.

Dimension 1: Power Distance

This measures the degree of unequal relationships between superiors and subordinates in a country. It informs us of the unequal distribution and exercise of power which are expected and accepted within a culture. In a high power-distance culture (e.g. China) leaders are expected to be autocratic and decisive, while their subordinates are seen as frequently afraid to express disagreement with their leaders. In a low power-distance culture (e.g., Austria) superiors usually consult with their subordinates for suggestions and opinions.

Dimension 2: Uncertainty Avoidance

This measures the (in)tolerance of ambiguity in a country. It indicates the extent to which society cope with novelty, ambiguity, and uncertainty. High uncertainty-avoidance cultures (e.g. Japan, France) people tend to be intolerant to unstructured and unpredictable situations. They prefer clarity and order; they favour rules and regulations. Alternatively, in low uncertainty-avoidance cultures (e.g. New Zealand, Denmark) people are used to unstructured and unpredictable situations. Rules are only established in case of absolute necessity.

Dimension 3: Individualism

This measures the degree of individualism in a country. It encompasses individualism and its opposite, collectivism. People in strongly individualistic cultures (e.g. USA, Australia) are expected to act according to their own interest, while people in collectivist cultures (e.g. Indonesia, Taiwan, Singapore) tend to act according to the interest of the society.

Dimension 4: Masculinity

This encompasses masculinity and femininity. In masculine cultures (e.g. Japan, Italy) ambition and performance are valued. In feminine cultures (e.g. Netherlands, Sweden) people value a welfare society.

The summary of the four dimension is listed in table 3.5.

**Table 3.5 Summary of the Four Dimensions**

| | Dimension | Rating | |
|---|---|---|---|
| | | High | Low |
| 1. | Power Distance | Autocratic | Consultative |
| 2. | Uncertainty Avoidance | Risk avoiders | Risk takers |
| 3. | Individualism | Individualistic | Collectivistic |
| 4. | Masculinity | Masculine | Feminine |

These four cultural dimensions do not exist independently; they interact with each other. There is a strong correlation between large power distance and collectivism, and between small power distance and individualism. Johnston has applied Hofstede's findings to aircraft operations. He states (Johnston, 1993) Hofstede's and other studies "serve to illustrate that culture exerts a pervasive, enduring influence on all human activities and actions. They also serve to remind us that the cockpit of an aircraft cannot be free of such social and cultural influences, however opaque they may be to the casual observer." Johnston draws comparison between countries and regions with strong individualistic and collectivist cultures and finds that strong individualistic countries and regions have notably safer aviation records. The same results applies to countries with a low power-distance index. The comparison clearly shows that power-distance and individualism indices are correlated with accident rates. The reasoning behind the results is that, in countries with a high power-distance and collectivist culture (such as most Asian countries), junior crew do not challenge the captain and expect him or her to give orders. Thus, a subordinate pilot will not question a captain's flying even when the captain deviates from standard operating procedures. The 1993 crash of Boeing 747-400 at Hong Kong exemplifies the influence of cockpit power gradient upon accidents. One of the major causal factors determined for this accident was that "the commander diminished the co-pilot's ability to monitor rollout progress and proper autobrake operation by instructing him to perform a non-standard duty and by keeping him ill-informed about his own intentions" (Civil Aviation Department-Hong Kong, 1995). By matching Hofstede's individualism and power-distance indices with accident statistics on hull loss rates, Boeing has also illustrated existence of a "possible" correlation. Countries with small power distances and high individualism tend to have lower accident rates; on the contrary, countries with large power distances and low individualism are found to have higher accident rates (see figures 3.11 & 3.12).

Boeing explains the results from the viewpoint of ergonomics, "It is interesting to note that the majority of the world's commercial jet aircraft were designed and built in the regions of the world with high individualism and low power-distance indices." Johnston (1993) also emphasised that "It would clearly be foolish to tackle cross-cultural problems of management and group functioning by blindly using a narrow and predefined repertoire of conceptions, prescriptions, and tools."

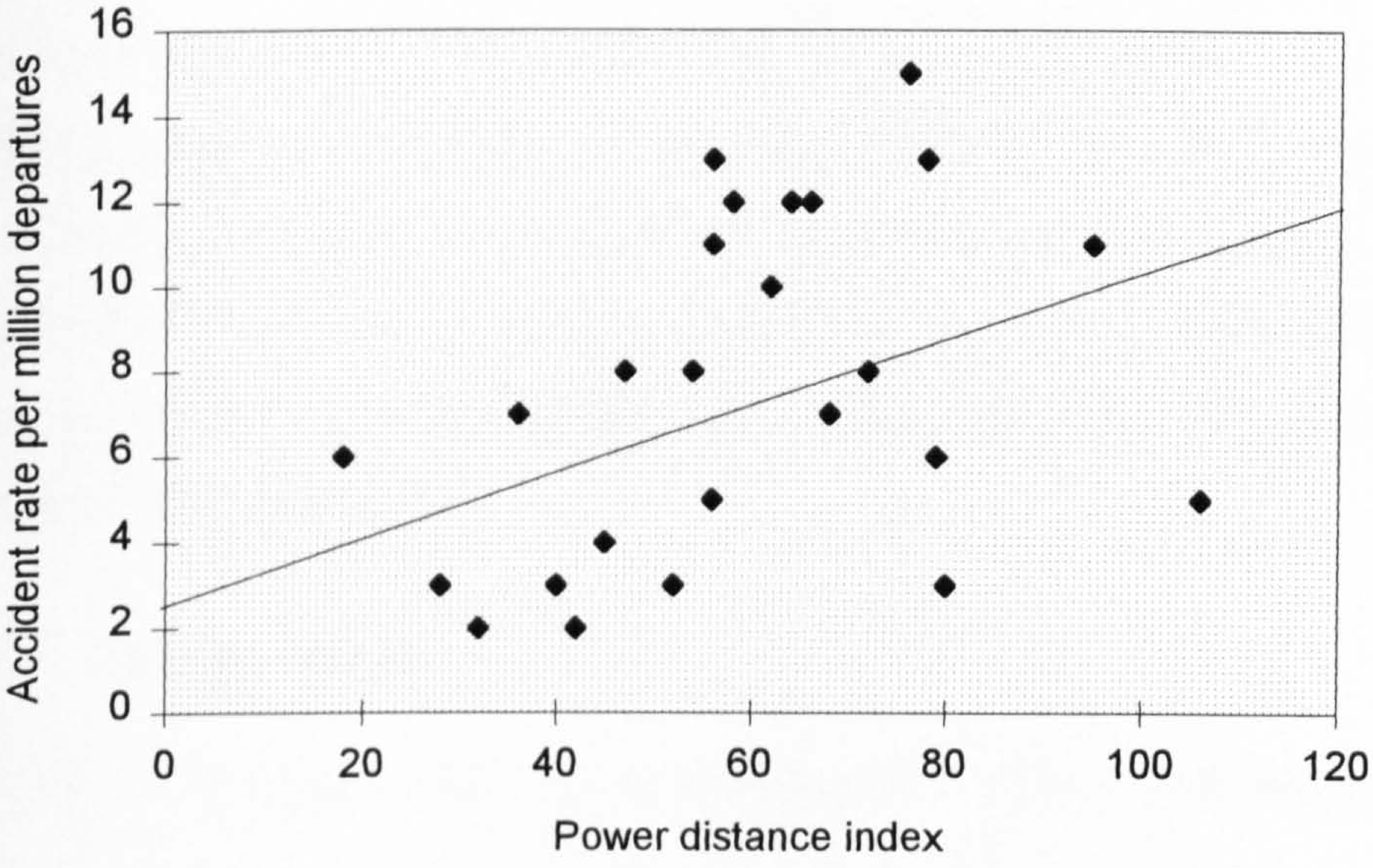



**Figure 3.11 Accident Rate as a Function of Power Distance Index**
All Accident 1959-1992
Source: Boeing, 1994

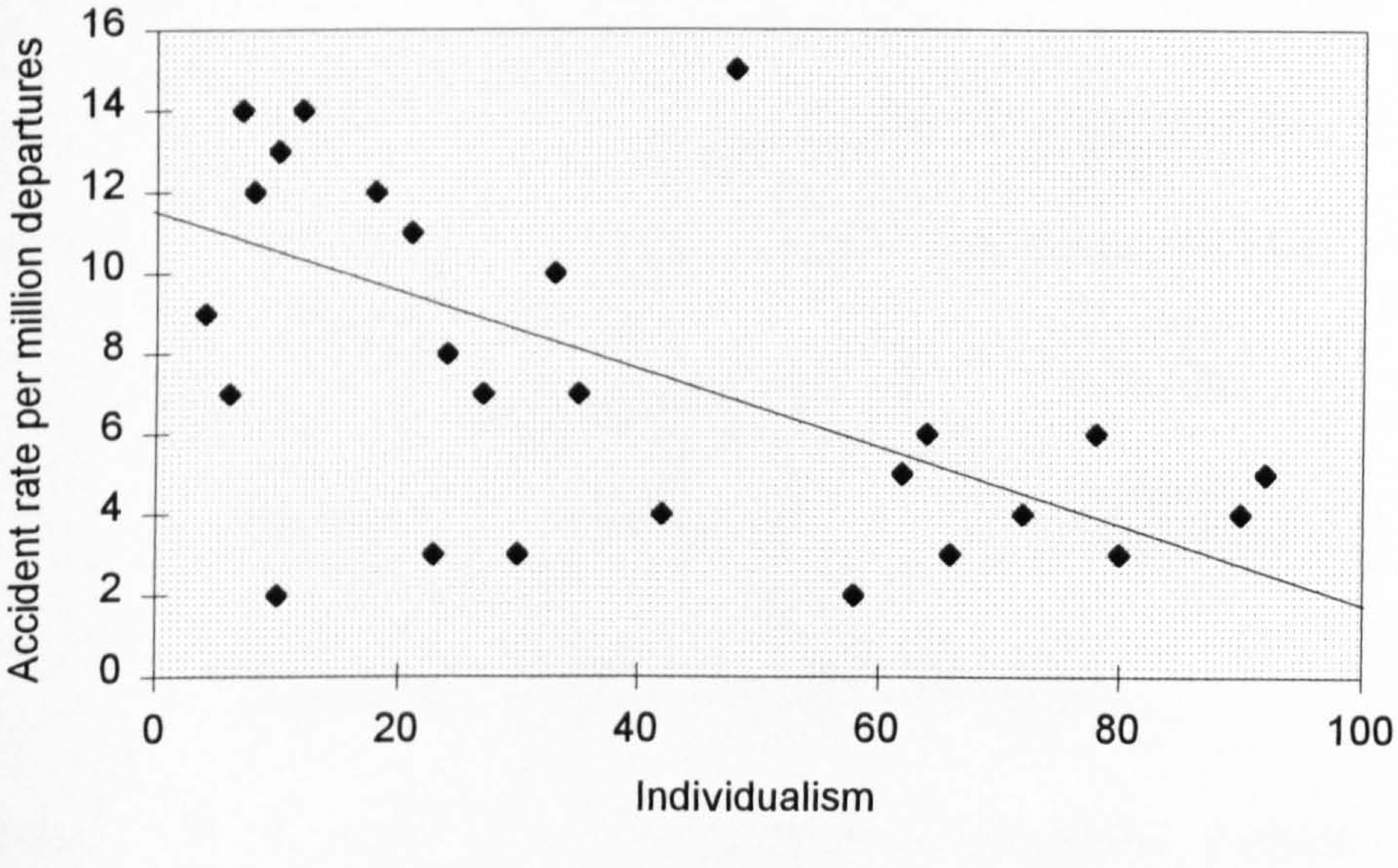



**Figure 3.12 Accident Rate as a Function of Individualism Index**
All Accident 1959-1992
Source: Boeing, 1994

## 3.7 Documentation and aviation safety

A complex human-machine system is more than a collection of hardware and software components. To support the efficiency and safety of the system, the organisational infrastructure of operating concepts and documentation must be consistent and logical. In other words, coherency between organisational culture in its broadest sense (e.g. philosophy and policies) and what actually happens in practice (e.g. procedures and records/practices) is vitally important for the safety management of a learning organisation.

### 3.7.1 Documentation

#### 3.7.1.1 The approach of two 'P's and one 'R': Policy, procedures and records

The function of safety management is to ensure that the safety level of an organisation is maintained. An organisation's safety documentation can be viewed as a hierarchy containing three tiers, as shown in Figure 3.13. All documentation moves from the highest level to the middle level, and from the middle level to the lowest level. In a well-organised safety system, changes at one level will seldom affect the levels above it but may affect those below.

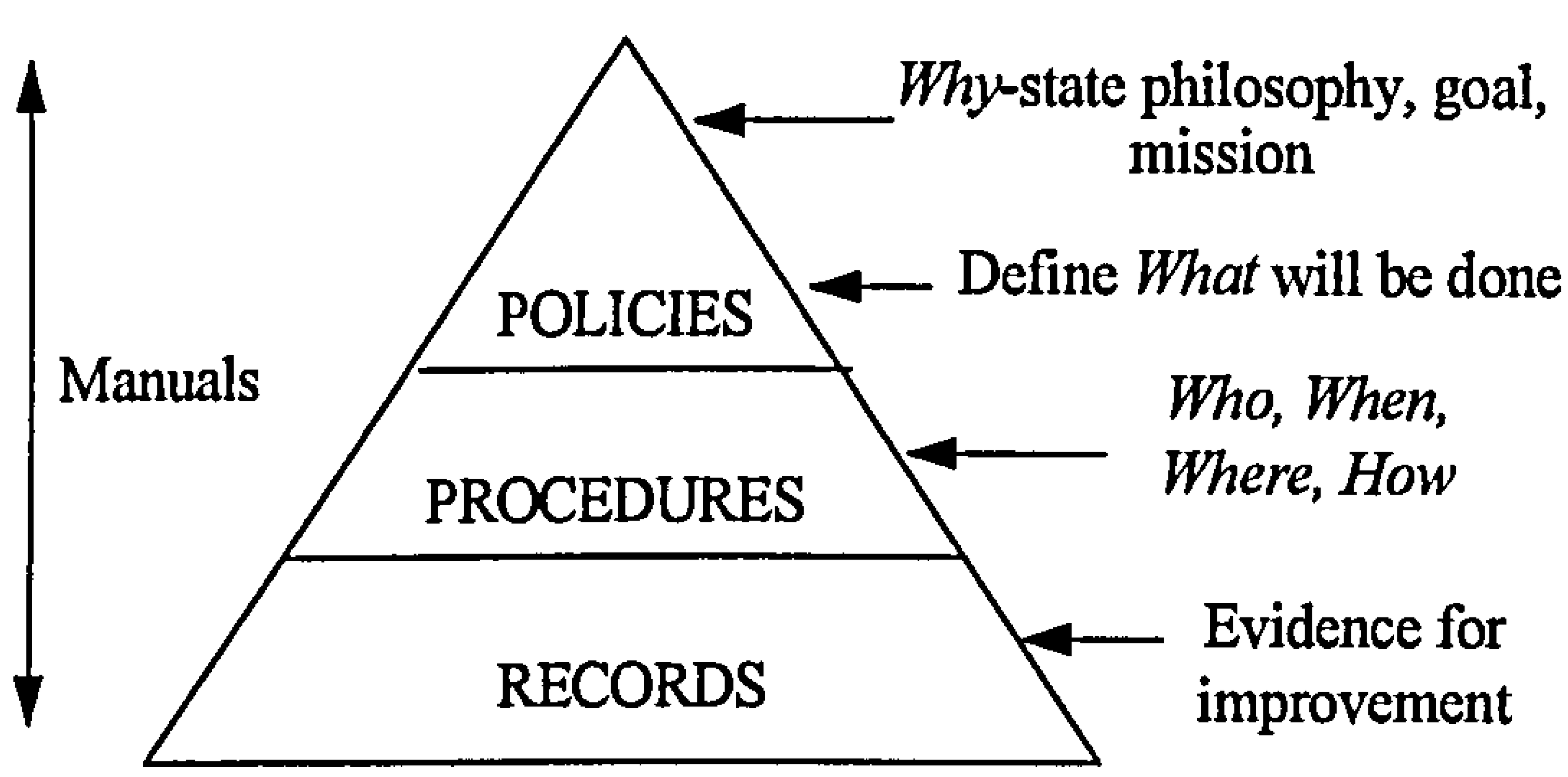



**Figure 3.13 The Documentation Pyramid**

*Policies* The first tier of documentation is the policy manual. This is the document that states an organisation's philosophy, goal and mission, and defines what will be done and why it should be done. A safety policy manual should be written clearly, precisely, practically, and easily to understand . A safety policy statement, providing guidance for what is to be done, should be a short simple definition of the organisation's safety intentions. For example: "We believe that an excellent company is by definition a safe company. Since we are committed to excellence it follows that minimising risk to customers, aircraft and services is inseparable from all other company objectives.", and "A good safety record goes hand in hand with high safety standards and productivity."

*Procedures* The second tier of documentation consists of procedures. These describe the methods that will be used to implement and perform the stated policies. In general, procedures specify the following six things:

1. What the task is.
2. When the task is conducted (time and sequence).
3. By whom it is conducted.
4. How the task is done (actions).
5. The sequence of actions.
6. What type of feedback is given (callout, actions etc.)

Procedures dictate the strategies that will be used and applied to all areas within the organisation to ensure the safety of the system. Thus, they should encompass all the details and be written in a manner that will allow for easy clear understanding. It should be noted that procedures are not required for all elements.

Procedures are sometimes called "work instructions" because they spell out how a job will be done. Thus, "procedures" are the most detailed of the documentation hierarchy.

*Records* Records are a way of documenting that policies and procedures have been followed. Records provide data for tracing actions taken as part of a specific process, and they offer information for taking corrective action and recalling products, if necessary.

*Manuals* Manuals are the written documents that set forth the priorities and goals of the organisation. They state the methods to be used by the various units in supporting these priorities and goals, and provide the organisation's policies and procedures that employees must comply with.

Manuals need to be upgraded to meet current needs, but the policies and procedures in the revised versions must be kept in agreement with the old ones and consistent with manuals used by other departments. All departments should review their policies and procedures annually to ensure that desired practices, procedures and regulations are in compliance with each other. It is recommended that manuals be a loose-leaf type so that revisions can be made easily; in addition, there should be a method of ensuring that revisions are received and recorded properly.

#### 3.7.1.2 Degani and Wiener's four 'P' approach: Philosophy, policy, procedures and practices

The Degani-Wiener approach emphasises a top-down methodology. Flight management first determines its overall operating philosophy; this in turn generates policies. Procedures, then, are derived from the policies. Based on procedures, practices are conducted by crew.

*Philosophy* The philosophy of operations is a combination of economic factors, public relations campaigns, new generations of aircraft, and major organisational changes. It is the operational concept, showing how the business of the airline will be conducted. A company's philosophy is largely influenced by the individual philosophies of the top decision makers, but also by the company's culture. The corporate culture permeates the company, and a philosophy of flight operations emerges either with or without clear statements. Philosophy generates policies, and may change with time when the operation becomes more mature.

*Policies* Policies are the broad specifications of the manner in which management expects operations to be performed, such as training, flying, maintenance, exercise of authority, personal conduct, etc. Policies can be defined and added over time. They affect procedures.

*Procedures* Procedures are step-by-step specifications drafted by management and provided to pilots. They are designed to dictate the manner in which tasks and sub-tasks are carried out and to provide a standardisation of cockpit duties. Degani and Wiener argue that if how operators conduct flight dock procedures needs to be understood, the infrastructure of the philosophy and policies should also be examined.

*Practices* In a later paper Degani and Wiener point out the significance of the roles of the pilot in flight operations, who is the one that actually carries out the procedures, and whose decisions and actions determine the system outcome. They, then, call for the need to add a fourth 'P', Practices, to address the gap between management's intentions and the reality of operational practices. Although all planning is top-down, bottom-up influences also exist because actual practices may affect procedures. Ideally, procedures and practices should be the same, but there are cases indicating that operators do not always follow any given procedure dictated by flight management (Lautman and Gallimore, 1988). The difference between procedures and practice is procedural deviation, or error, which will be discussed later in the chapter.

The Ground Proximity Warning System (GPWS) Policy of British Airways is a good example to illustrate the four 'P' framework (ICAO, 1993).

- *Philosophy*: it is a corporate goal to be a safe and secure airline, as stated in the corporate mission and goals.
- *Policy*: in the event of a full, or partial, "Pull-up" or other hard (red) warning, the following action must be taken promptly:

  a) Below MSA (Minimum Safe Altitude)
  Announce "PULL-UP GO-AROUND"
  Immediately complete the pull-up manoeuvre in all circumstances.

  b) At and Above MSA
  Immediately assess aircraft position, altitude and vertical speed. If proximity to MSA is in doubt, take action as in a) above.

- *Procedure*: GPWS pull-up manoeuvre is described in fleet-specific manuals. Describe the call-outs by the handling pilot and the non-handling pilot - procedures at and below MSA and procedures above MSA; define MSA during climb and descent in case of ambiguities and include additional operational information deemed appropriate for the crews to observe the GPWS Policy.
- *Practices*: do flight crews observe the policy and follow the procedure in operational conditions?

The original policy of GPWS mandated an immediate pull-up upon receipt of any GPWS warning. Operational feedback, however, indicated the unreliability of the GPWS alerts led to pilot deviation in 60% of occasions. An obvious discrepancy between the three first Ps and the last one - Practices - was evident. Based on this feedback data and its analysis, the safety services of the operator amended its GPWS policy to that listed in the above paragraph, with the purpose of ensuring compliance with the policy on all occasions.

### 3.7.2 Standard operating procedures

Standard operating procedures (SOPs) are operating rules which provide operators with step-by-step guidance for carrying out their operations in predictable situations. Well-designed SOPs should be able to ensure efficient and error resistant actions, enhance co-ordination between operators in the system, and exercise quality control by management and regulating agencies over the operators.

The flawlessness obtained from standardisation of operating procedures is essential in high-risk endeavours such as aircraft operations. Based on a broad concept of the user's operation, procedures specify how to perform tasks efficiently and safely in keeping with the company's basic operating philosophy. Standardisation ensures that "the best way" of doing things may transcend the whole organisation, encompassing fleets of very different aircraft. Standardisation makes sure that crews are trained to behave in one consistent and predictable way, so that each pilot should know exactly what to expect of another pilot.

The importance of SOPs is much greater than standardisation. First, SOPs provide for flight operations with a structure, which gives crew members the ability to anticipate each other's actions. In the cockpit, the most important task of the pilot-not-flying (PNF) is to monitor the adherence to procedures and clearances by the pilot-flying (PF). Thus, one of the virtues of SOPs is to offer the PNF standards for effective monitoring. Secondly, by providing consistent and safe methods of accomplishing many normal (and abnormal) tasks, SOPs help flight crews to deal calmly with unexpected or inexperienced situations. Thirdly, and perhaps most importantly, adherence to SOPs helps to keep pilots active in long-term planning - for any action taken there is an anticipated procedure or response. As long as a situation is anticipated and can be practised, there is a set procedures for dealing with it. SOPs provide pilots with these anticipated responses and procedures, and all good pilots rely on them in flight operations. In addition to the three benefits above, abiding by SOPs may also minimise language barriers when multi-national crews work together.

As discussed in the previous chapter, many past accidents and incidents are correlated to deviation from standard operating procedures. It should be noted that although SOPs promote uniformity and serve as an intervention against human error, they cannot ensure absolutely safe operations. In situations where procedures are not adequate for the task or are not compatible with the operating environment, adherence to them might lead a responsible operator to execute unsafe operations. Degani and Wiener (1994) proclaim that operations of high-risk systems need the support of procedures and human cognition as well. They emphasise that "The role of management should be to provide the best possible baseline for its crews, and then train and standardise to this baseline. No procedure is a substitute for an intelligent operator."

Here is a dramatic example:

On 19 July 1989, a United Airlines (UAL) DC-10 suffered a total loss of hydraulic flight controls during cruise flight.[16] Because the possibility of total loss of hydraulic-powered flight controls was considered so remote as to negate any requirement for an appropriate procedure to counter such a situation, the flight crew could not be taught how to control the aircraft and land successfully. Under the circumstances, although the aircraft subsequently crashed during an attempted landing, the UAL flightcrew performance was highly commendable and greatly exceeded reasonable expectations.

Additionally, SOPs with poor design are apt to promote errors on the part of operators. Two Boeing 747-400 cases revealed the problem of using the adaptability of the human beings to make up for a shortfall in the system. After being given a late runway change, the captain in each of these cases was busy at sorting out the flight management system and changing the instrument landing system (ILS) frequency so that the aircraft was positioned high on the approach and consequently landed deep. After this, the 747-400 Fleet Newsletter suggested a solution to the problem: " Rehearse what you will do in the event of a late runway change, possibly setting up the parallel runway in advance in route 2 of the FMS" (Seaman, 1992).

The above examples emphasise the importance of the feedback process. Feedback provides an effective channel of communication between line and management, a channel for line pilots to offer suggestions and information regarding SOPs for the attention of the procedure designers and for re-evaluation by management. The feedback process can serve to eliminate the differences between actual operations and written procedures.

[16] The UAL DC-10 flight 232 experienced a catastrophic failure of the No. 2 engine during cruise flight. The separation, fragmentation and forceful discharge of the stage 1 fan rotor assembly parts from the No 2 engine led to the loss of the three hydraulic systems that powered the airplane's flight controls. The flightcrew experienced severe difficulties controlling the airplane, which subsequently crashed during an attempted landing at Sioux Gateway Airport, Iowa. There were 235 passengers and 11 crewmember onboard. One flight attendant and 110 passengers were fatally injured.

### 3.7.3 Procedural deviation influences on safety

Pilots are supposed to conform to SOPs when on the flight deck, but in reality they can decide to conform to or deviate from them. It is often the case when written procedures are incompatible with the operational environment, or have technical deficiencies, increase the workload, or create conflict in time management, etc., flight crews may react by resisting and deviating from SOPs.

Procedural deviation results from problems within the human-procedure context. Deviations may be trivial or significant. In most cases, deviations are not apparent and left unresolved in the system until unpredicted interactions of failures and deviations manifest themselves in an accident or an incident. Lautman and Gallimore (1988) conducted a study of jet-transport aircraft accident reports to 'better understand accident cause factors' in commercial airline operations. They analysed 93 jet hull-loss accidents that occurred between 1977 and 1984, and finding that the leading crew-causal factor in their sample was 'pilot deviation from basic operational procedures' (Figure 3.14). These findings are also clearly supported by the airline accidents in Asia (see Figure 3.15; Chapter 2, Table 2.3) and in Taiwan (see Chapter 2, Table 2.4). Additionally, Boeing's analysis of jet transport accident records (1982 through 1991) shows that among the thirty seven identified accident prevention strategies, the most common one is "Flying Pilot Adherence to Procedures" (Weener and Russell, 1993).

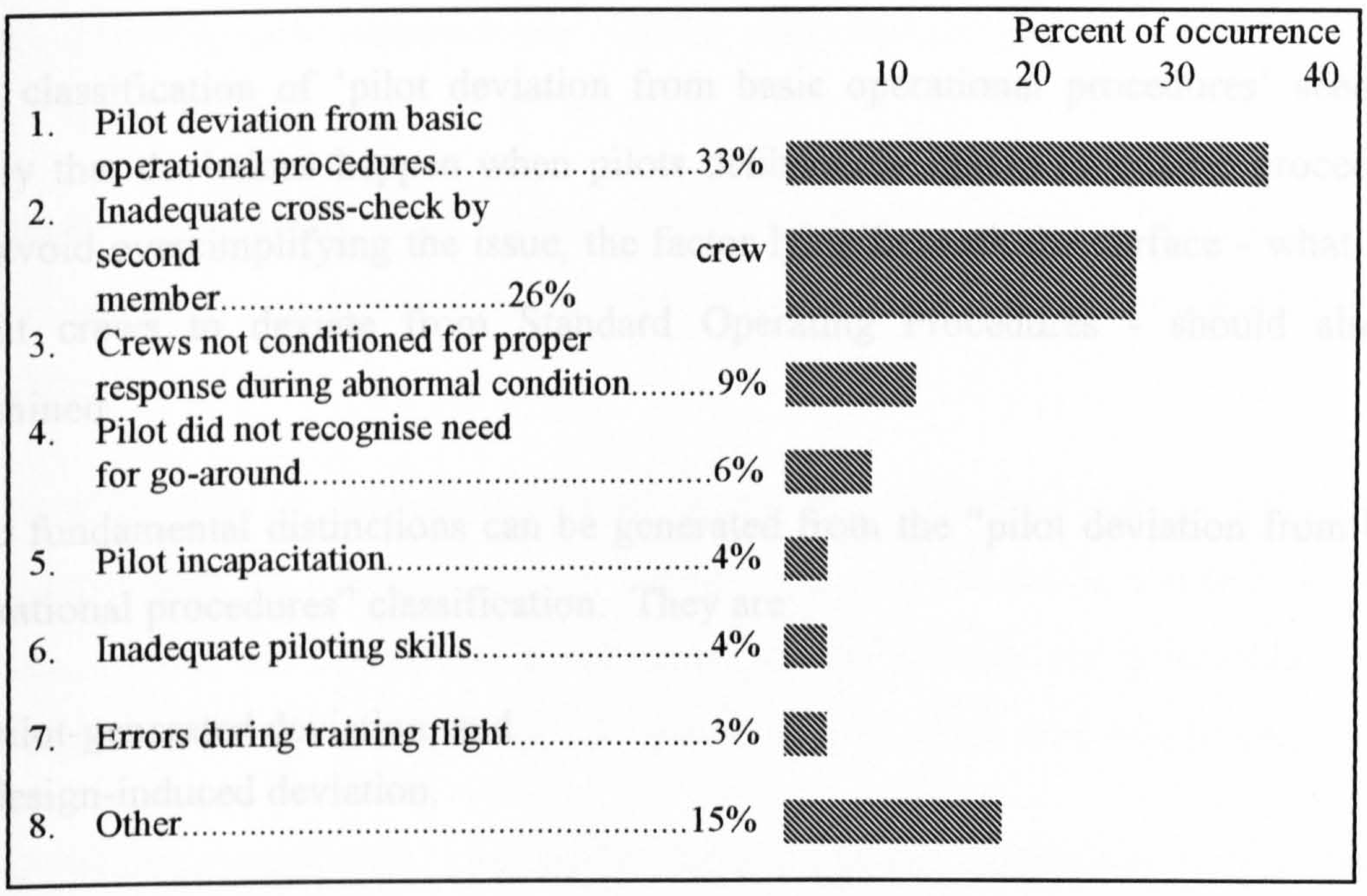



**Figure 3.14 Significant crew-caused factors in 93 hull-loss accidents**

(Source: Adapted from Lautman and Gallimore, 1988)

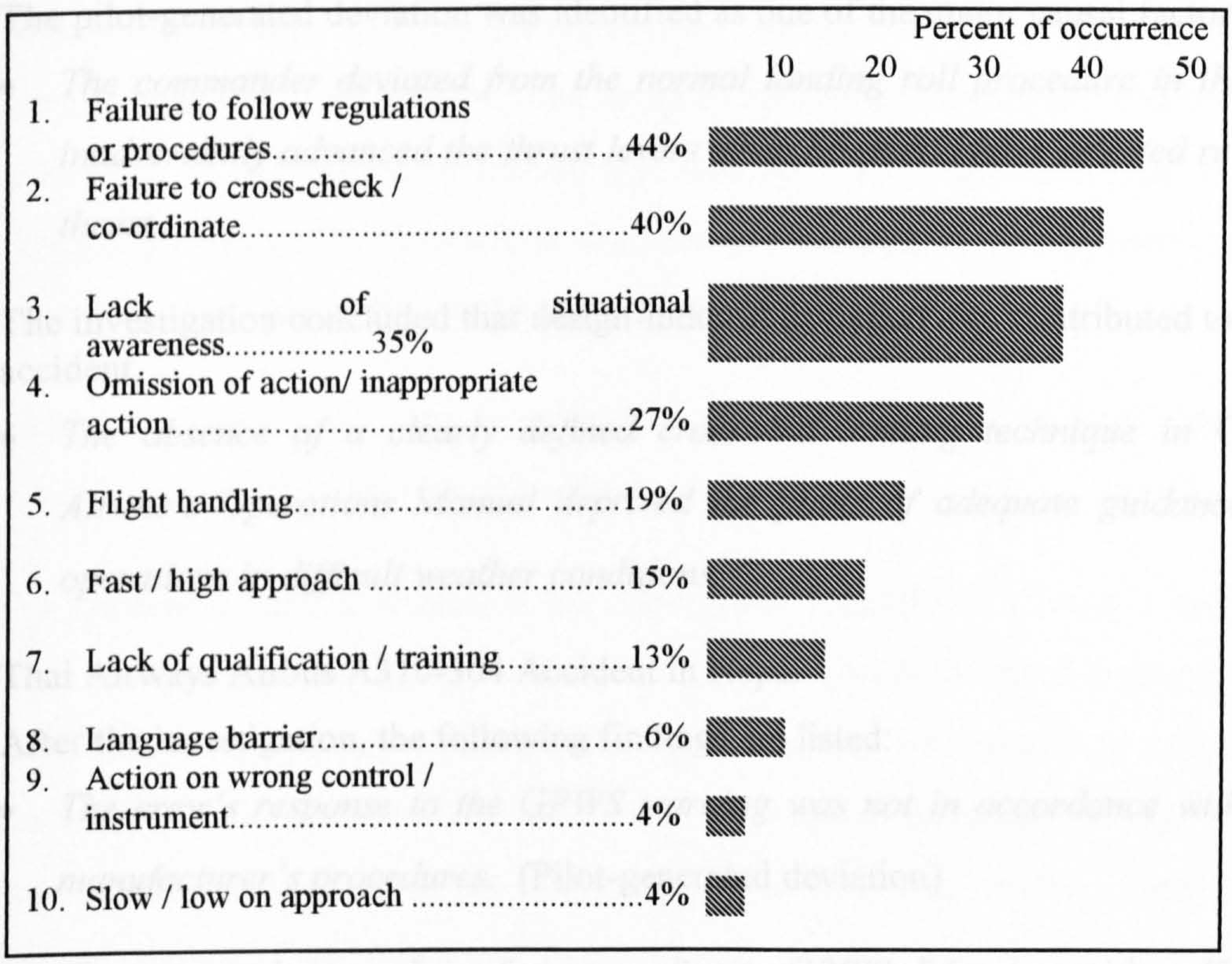



**Figure 3.15 Significant crew-caused factors in Asia**

(Each accident may have more than one Causal Factor)

Source: ICAO, Asian CAAs and aircraft manufacturers

The classification of 'pilot deviation from basic operational procedures' seems to imply that deviations happen when pilots deliberately ignore or misuse procedures. To avoid oversimplifying the issue, the factor lying beneath the surface - what leads flight crews to deviate from Standard Operating Procedures - should also be examined.

Two fundamental distinctions can be generated from the "pilot deviation from basic operational procedures" classification. They are:

- pilot-generated deviation, and
- design-induced deviation.

The aviation accident reports of Hong Kong and Nepal accidents illustrate the point.

1. China Airlines Boeing 747-409B Accident in Hong Kong

   The pilot-generated deviation was identified as one of the major causal factors.

   - *The commander deviated from the normal landing roll procedure in that he inadvertently advanced the thrust levers when he should have selected reverse thrust.*

   The investigation concluded that design-induced deviation also contributed to the accident.

   - *The absence of a clearly defined crosswind landing technique in China Airline's Operations Manual deprived the pilots of adequate guidance for operations in difficult weather conditions.*

2. Thai Airways Airbus A310-304 Accident in Nepal

   After the investigation, the following findings are listed:

   - *The crew's response to the GPWS warning was not in accordance with the manufacturer's procedures.* (Pilot-generated deviation)

   - *The operator's procedures for responding to GPWS did not provide sufficient guidance to the crew.* (Design-induced deviation)

- *The Captain assessed the GPWS warning as false.* (Design-induced deviation)

Attempting to increase the attention paid to less explicit factors, Degani & Wiener (1991) subdivide the design-induced deviation into four categories and highlight their deficiencies.

*Incompatibility of the procedure with the operational environment* Incompatibility of procedures with the operational environment is usually caused by the lack of proper policies. Thus, the design and development of the policies and procedures should take into consideration the operational environment in which they will be used.

*Sequential incompatibility* Sequential deficiencies are particularly critical because of the time limitation, workload and level of stress involved in dealing with abnormal/emergency situation.

*Incompatibility of paperwork and computerwork* Much of the paperwork and procedures in use today by airlines were designed for traditional aircraft, and have not been adapted to the advanced technology cockpits. It is necessary for carriers operating high technology aircraft to examine every aspect of their operations and paperwork for incompatibility with the new aircraft.

*Wording* The words used in operating procedures should be consistent and unambiguous in order to prevent misunderstanding.

In one incident a captain consulted the appropriate manual for solving a technical problem. The captain and the first officer came up with three different interpretations of the instructions. In this situation, the flight engineer was unable to adjudicate satisfactorily. The captain then asked his 12-year-old daughter, sitting on the jumpseat behind him, whether she could understand what was written. Needless to say, it was complete "gobbledegook" to her as well!

The point is that "if manuals are not written in language that is clear to an intelligent 12-year-old, then there is a good chance that flight crews will not understand what is required of them when they are trying to cope with problems in the most adverse of circumstances, when their attention will inevitably be divided among a number of conflicting and competing tasks" (Seaman, 1992).

To summarise, the safety of high-technology organisations depends on well-established policies and procedures. Without them it is impossible to ensure that operations will produce the desired results. Management's role must be to maintain an active involvement in reducing the difference between procedures and actual operations. The establishment of a hazard/incident reporting system in combination with undertaking regular audits in an organisation will help improve the links between the two 'P's and 'R', or the four 4 'P's.

## 3.8 The "New Third Pilot" automation and safety

The aircraft automation advances made over the last few decades have been developed to cope with two primary objectives: to provide economic benefits to the aircraft operator and to improve flight safety. Today's advanced level of automation have delivered on economic promises, but their safety effectiveness has been a subject of dispute.

### 3.8.1 The reasons for automation

Long before the microprocessor revolution, the call for automation had resulted in the prodigious utilisation of analogue devices, such as autopilots, flight directors, yaw dampers, and various alerting devices, in the flight deck. Recent advances in microprocessors and display systems have merely served as a catalyst to hasten the process of flight-deck automation and bring more rapid changes. There are three principal reasons for aircraft automation:

- Increasing availability of sophisticated technology (see the next section)
- Economical benefits
- Safety improvement

these amazing changes in aircraft automation could not have been possible without the rapid advances in microprocessor technology. Economic benefits have encouraged the trend of automation. The influence of human factors or pilot error in accident causation has also prompted the implementation of flight deck automation.

Economical benefits are to be derived from a combination of factors as listed below (Learner, 1983; Wiener & Curry, 1981).

1. Personnel costs can be cut because crew size can be reduced through automation of the crew's tasks.
2. The new generation of solid state avionics and display systems can not only improve reliability but also reduce maintenance.
3. An automated monitoring and recording systems can save money in maintenance of high-value systems, such as engines and auxiliary power units.

4. Flight automation can improve the accuracy of routes and approaches, and foster safer ground operations.
5. Increasing automation also leads to more economical, fuel-efficient operation.

The principal rationale for cockpit automation is to reduce pilot workload and improve safety. Wiener (1988) presents three related reasons for justifing this rationale: (1) to enable effective pilot performance during both normal and emergency operations; (2) to increase the scanning capability of the pilot; and (3) allow the certification of aircraft for two crew operations.

*Effective performance during normal and emergency conditions* A principal reason for the implementation of automation is the need to relieve the flight crew of routine manual control and mental computations so that there is time to supervise the flight more effectively and to perform optimally in high workload and emergency conditions.

*Increased scanning capability* As shown in Chapter 2 Figure 2.3, more than 50% of airline accidents occur at lower altitudes; thus, one of the most important pilot monitoring tasks is to scan for other aircraft during flight. Automation enables pilots to spend less time with their heads in the cockpit so that more time may be devoted to scanning outside.

*Crew size* The reduction in pilot workload through automation permits two-pilot crews to complete a task previously performed by three. Nowadays aircraft, including wide-body airliners, can be designed and certified for two crew operation.

Despite the apparent attractions of automation, however, there are a number of less obvious shortcomings. Further discussion about the problems associated with automation is provided later in the section.

### 3.8.2 Aircraft automation development

Cockpit automation began in the mid-1930's with the introduction of crude autopilots. By the 1950's more sophisticated models were developed and installed on aircraft of the Super Constellation and DC-6 generation. In the jet age, flight guidance systems consisted of autopilots and other automatic devices, such as flight directors, area navigation (RNAV) and basic autothrottles. Autoslats, autospoilers and autobrakes also became part of the automation package.

At the beginning of the eighties, rudimentary forms of computer-based error elimination and protection were first found in the "glass cockpit"s aircraft of the Boeing 757 and 767 aircraft. The Airbus A320, introduced in 1987, took error protection one step further. It possessed a fly-by-wire control system and side stick controllers in place of the usual control columns in the cockpit. The fly-by-wire feature offered the opportunity to fly manoeuvres such as maximum safe angle of attack (AOA) for windshear escape, with no danger of entering a stall.

Although aircraft automation was first seen in the stability augmentation system invented by Sir Hiram Maxim in 1891 (see Figure 3.16), it was the availability of very compact digital computers, 90 years after this, that made it possible to automate control, information presentation and management functions. Consequently, the role of pilot has changed to being a supervisor of automated equipment.

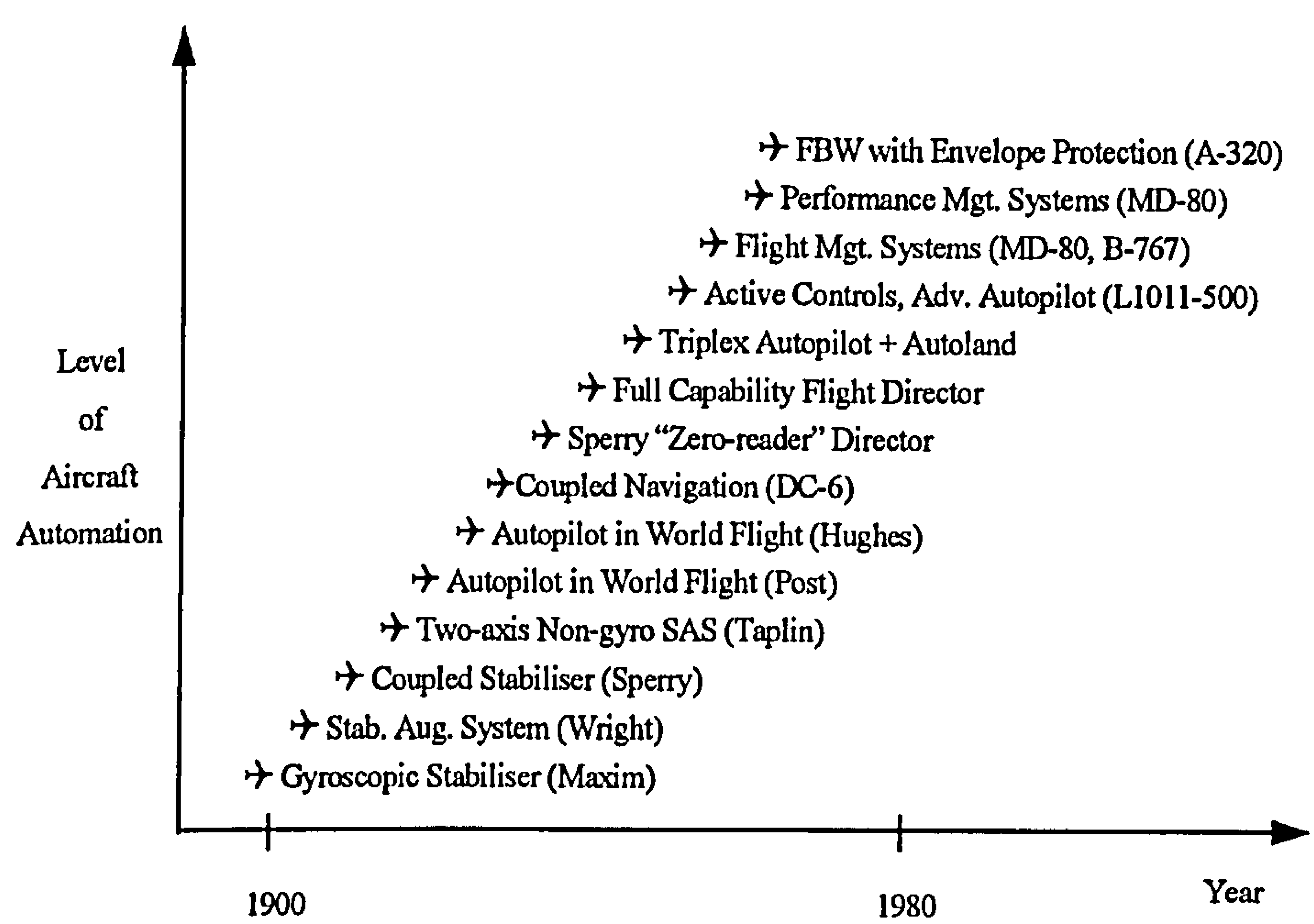



**Figure 3.16 A Chronology of Aircraft Automation**
Source: revised from Billings, 1991

### 3.8.3 Problems associated with automation

Flight automation innovations have been introduced to increase safety and efficiency. Automation and computerisation are employed in almost all branches of the aviation system today. It is undeniable that airlines can secure safety and financial benefits from the increased use of computers and automation, but some new and potentially serious hazards associated with the new technology have also arisen.

The industry has weighed the advantages with the disadvantages, and has concluded that increasing automation is the correct course to follow. However, the disadvantages associated with automation must be examined.

Table 3.7 lists the past accidents and incidents in which automation has been a contributing factor. Each of these accidents or incidents shows that the pilots either did not understand what the automation was doing or did not receive adequate feedback from the automated systems.

**Table 3.7 Accidents/Incidents in Which Automation Has Been a Factor**

| DATE | TYPE | LOCATION | FACTOR | SEVERITY |
|---|---|---|---|---|
| Feb. 1985 | B747 | Nr San Francisco | overconfidence | accident |
| Apr. 1988 | MD-80 | Detroit | autopilot design | accident |
| Jun. 1988 | A320 | Habsheim | overconfidence | accident |
| Jul. 1988 | A320 | Gatwick | mode understanding | incident |
| Jun. 1989 | B767 | Boston | mode understanding | incident |
| Feb. 1990 | A320 | Bangalore | mode understanding | accident |
| Jun. 1990 | A320 | San Diego | mode understanding | incident |
| Feb. 1991 | A310 | Moscow | pilot vs autopilot | incident |
| Jan. 1992 | A320 | Strasbourg | mode understanding | accident |
| Sep. 1993 | A320 | Warsaw | authoritarian system | accident |
| Apr. 1994 | A300 | Nagoya | pilot vs autopilot | accident |
| Jun. 1994 | B757 | Manchester | autopilot design | incident |
| Jun. 1994 | A330 | Toulouse | autopilot design | accident |
| Sep. 1994 | A310 | Orly | autopilot design | incident |

Source: Compiled from AW & ST, Jan. 1995 and Billings, 1996

Automation in today's advanced aviation systems seldom provide all of the benefits promised, and increasing dependence on flight automation breeds new kinds of safety problem that might not occur with older flight deck design. Perils of automation, as listed below, are generally man-machine interface problems.

1. *Complacency* Automation is progressively changing the role of the pilot from an active operator to a system monitor. Studies show that after a period of time in passive monitoring situations, a human's ability to detect a failure diminishes (Foushee, 1991). Parasuraman, Molloy, and Singh (1993) also point out that "the presence of automation affects the efficiency of human monitoring." Excessive reliance upon automation, for example, may cause serious problems in abnormal situations or emergencies.

2. *False Alarms* Failure of automated equipment makes the operator question its validity. For example, the original Traffic Collision Avoidance System (TCAS) was unusable due to a high false-alarm rate. Although software improvements have been implemented to make it more reliable, the improved version (TCAS II) still has high false alarm rates in high-density traffic areas (Kantowitz, 1992). Wickens (1984) indicates that false alarms lead to distrust of indicators and "produce the 'voluntary vigilance decrement' - a conscious conservative adjustment of the detection criterion."

3. *Skill Degradation* Automation increases training requirements. It takes longer for pilots to learn a more complex automated system. Furthermore, flying with automation deprives the pilot of practice in the manual mode which may induce a loss of proficiency, the skills that are critically important when the automated system malfunctions. In addition, there is often more to take care of when intervention is unavoidable, because the system was probably automated to increase its capability. Pilots, thus, require additional simulator time to maintain the skills in emergency situations when the system malfunctions and their workload is at its peak.

4. *Manual Take-over Problem* Automated system makes the crew unaware of its state at all times. Norman (1990) discussed the hazards of automatic compensation for abnormal events and conditions about which the crew was unaware. The difficulty lies in the lack of awareness of either the problem or the

automatic compensation by the crew when automation reaches its limit to compensate and the crew need to take over. Take the well-known case of the China Airlines Boeing 747-200 (NTSB, 1985) for an example. The captain lost control of the aircraft because he was distracted from his flight monitoring duties by his participation with the flight engineer in the evaluation of the No. 4 engine's malfunction.

5. *Mental Workload Increase* Current automation systems are machine-centred, and functions are allocated to reduce pilots' workload under routine conditions but seldom support them in difficult situations. Pilots perceive some reduction in the total workload, but probably less than that claimed by the manufacturers during the certification process. Wiener (1985) argues that designers emphasise reducing manual workload, but does not account adequately for the mental workload. Bainbridge (1987) gives an insight into the ironies of automation. He indicates that, "the designer who tries to eliminate the operator still leaves the operator to do the tasks which the designer cannot think how to automate...the operator can be left with an arbitrary collection of tasks, and little thought may have been given to providing support for them."

6. *Error Relocation* The rapid expansion of automation in the cockpit does not remove human error; on the contrary, it merely relocates its sources to a different level. The research of Wiener and Curry suggests that automation merely changes the nature of error, and possibly increases the severity of its consequences (Curry, 1985; Wiener, 1985, 1988, 1989). In brief, computer-controlled flight may invite large blunders while eliminating the small errors seen in manual systems.

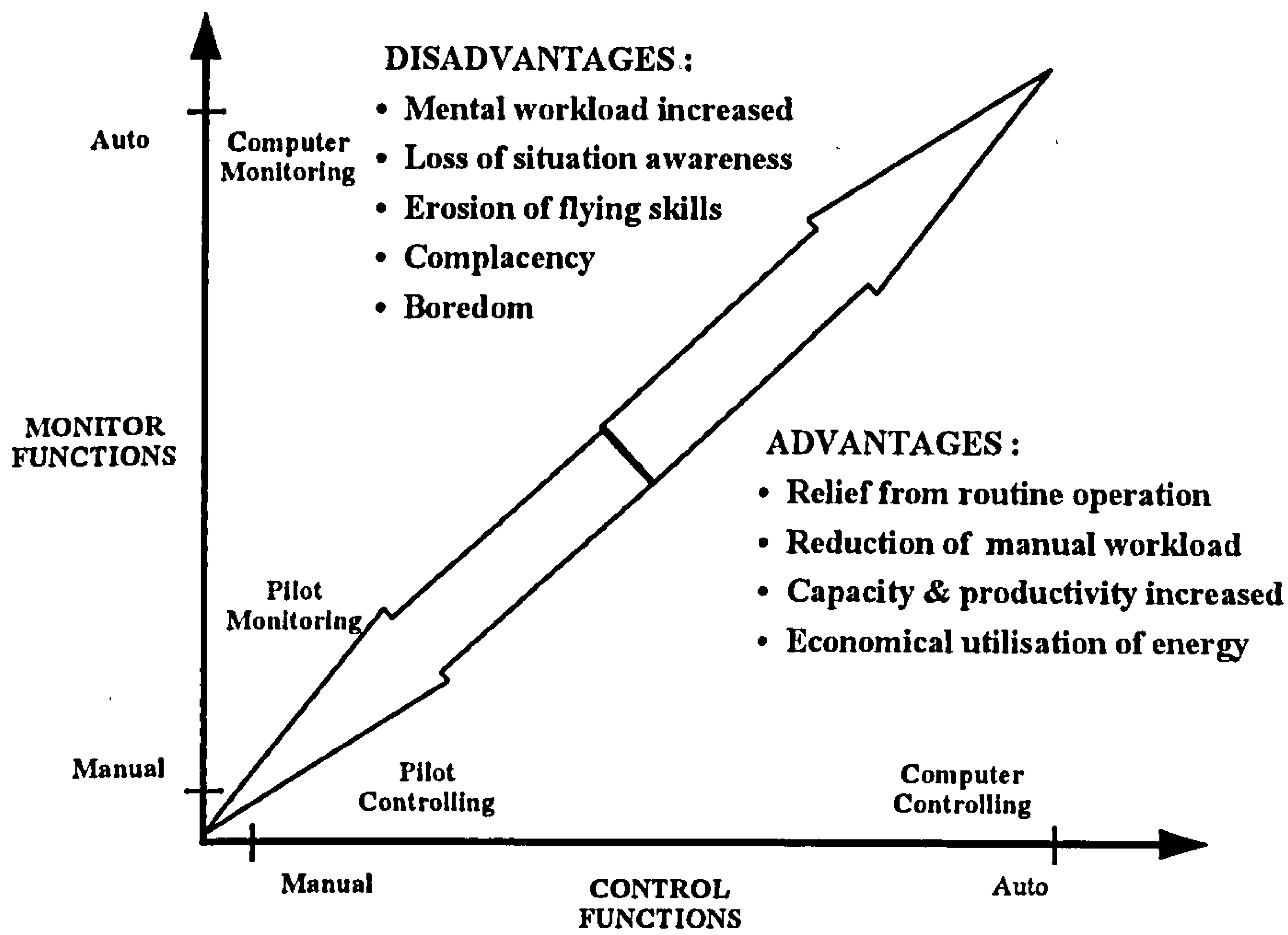



**Figure 3.17 Two Dimensions of Automation: Summary the Advantages and Disadvantages of Automation.**

### 3.8.4 Differences in manufacturer philosophy

Sources of human error are not confined in operational level. Errors in the manufacture and maintenance of automated equipment can also be potentially disastrous.

The more complex that computers become and the more authority they are given in the cockpit, the more chances for breakdown in communication between the pilots and automated systems there are. In this regard, the three major commercial aircraft manufacturers have different philosophies.

Airbus Industrie officials believe that automation serve to prevent a pilot from inadvertently exceeding safety limits. Hence, the "hard" speed envelope protection features in Airbus fly-by-wire aircraft are designed to prevent a pilot from stalling the aircraft in most circumstances and from pulling accelerations of more than 2.5g, even in an emergency.

Boeing's approach is to never bypass the crew. The flight crew plays a crucial role in the aviation system, so the design of automation must be based on an understanding of the roles, responsibilities, capabilities and limitations of the human crew. Automation is a tool to aid pilots and should not be given authority to override pilot inputs.

McDonnell Douglas' philosophy to advanced cockpit design includes a similar "soft" protection scheme to Boeing's. However, the MD-11 design removes the pilot function in many situations and gives a large amount of authority to sophisticated automation systems.

Technology-centred automation may be based on the designer's view that the human operator is unreliable and inefficient and should therefore be eliminated from the system (Belai, 1995). Recent accidents involving aircraft equipped with automation and computerisation highlight some significant problems with this approach. Firstly, errors in system design can in fact be a major source of operating problems. Secondly, automation is introduced to reduce human error and workload, but frequently, automation leaves the operator to cope with different and more demanding situations which automation is not programmed to handle. To this we can add the fact that automation is not, after all, unerring and able to fully replace fallible humans. To make matters worse, automation usually fails in mysterious and unpredictable ways and the human is expected to match the exigencies of the machine. For automation to be effective and at the same time satisfy minimum safety standards, a human-centred approach needs to be designed and employed. This should assist the human operator by providing management options, timely information, and explanations of its actions and intentions.

### 3.8.5 Intervention for safety management

The purpose of emphasising some of the potential problems that may occur with glass cockpits is not to condemn automation but instead to highlight the need for a more viable balance for ensuring human and machine co-operation in performing tasks.

Lauber (1991) pinpoints the key problem of human and machine co-operation: "Although technology seems to be readily available and generally reliable, what is missing are principles, rules and guidelines defining the relationship between that technology and the humans who must operate it." In other words, how automation should be implemented to meet the needs of the operators is of fundamental.

As pointed out in the previous section, designers should develop a system taking human capabilities and limitations into account. Higgins (1996) clearly states the design principles of human-centred automation that could be used as areference:

1. Design must address fundamental human strengths, limitations and individual differences
2. Design must recognise the captains authority and aid both pilots' responsibilities
3. New designs should be based on past training and operational experience
4. The hierarchy of design alternatives is simplicity, redundancy and automation
5. New technologies and functional capabilities should only be used when:
   - the result is clear and there are distinct operational or efficiency advantages, and then
   - only if there is no adverse effect on the human machine interface.
6. Automation should be applied as a tool to aid, not replace the pilot
7. Designs must apply human error tolerance and avoidance techniques
8. Presentation of information to the crew must support the pilot task priority

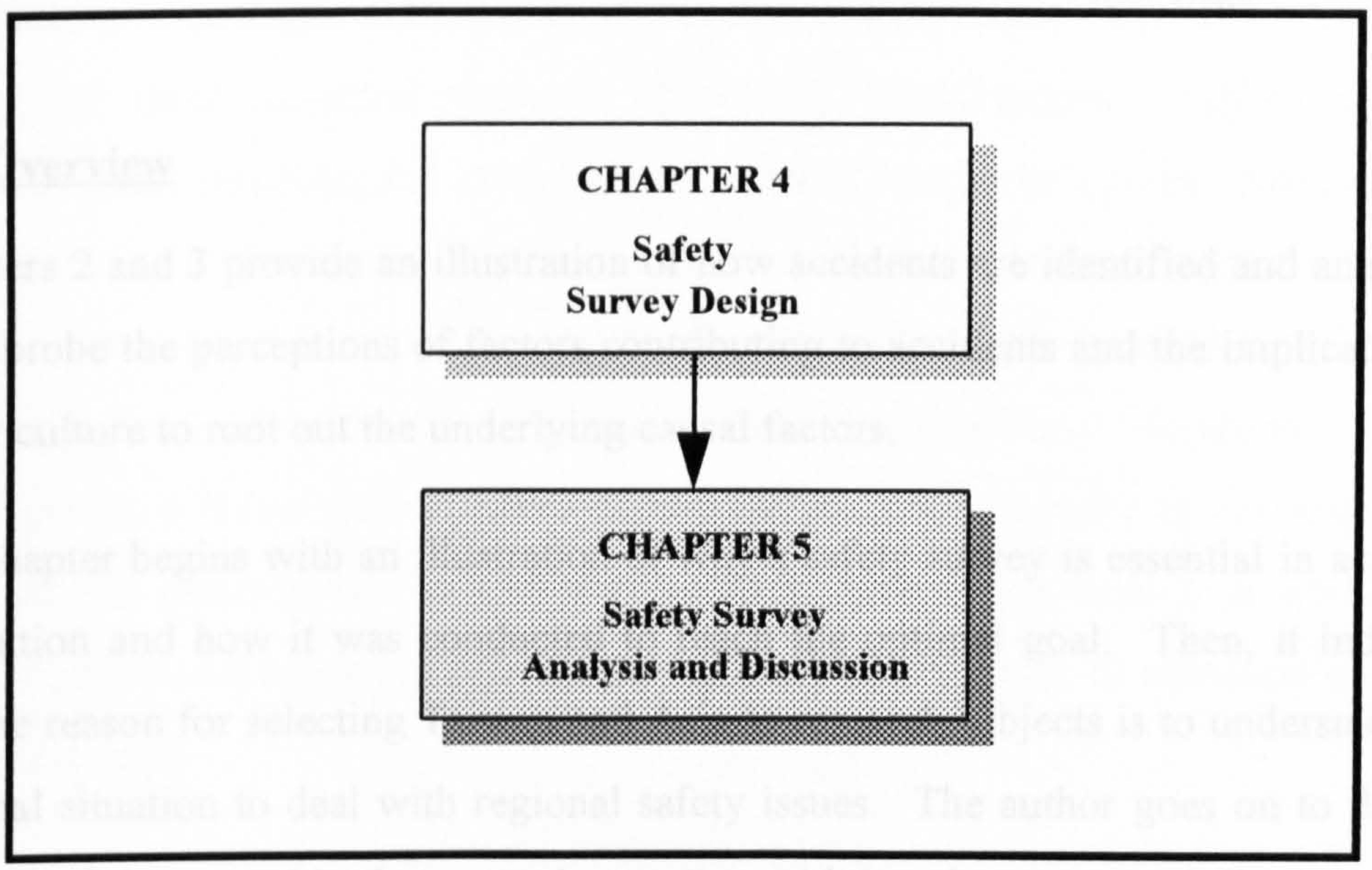
Additionally, airlines can also take steps to reduce the safety concerns bred by increasing dependence of flight automation. Providing specialised instruction in automation, changing training procedures and using partial simulators all can help.

Some training programmes overemphasise those of autoflight at all times and not offer enough instruction on when to use it and when to disengage it. Consequently, pilots sometimes hesitate to turn off the automation when a problem, or even just a change in flight plan, occurs. As Wiener emphasises, "When there is confusion, the best solution is to turn the system off and fly the aircraft just like an old Boeing 727."

Airline safety management must ensure that pilots are trained to use the level of automation required by their tasks, and they should be taught strategies for dealing adequately with the human-machine relationship.

# PART II

## Airline Safety Management Survey




**The goal of zero accident is a noble one and should be pursued as a matter of philosophical principle. Although it is impossible to wholly eliminate human fallibility, system failures, and hazards, it is definitely worth trying to do so.**

**In aviation, airlines must manage the organizational factors that influence safety. With attempt to eliminate active and in particular latent failures within their operational processes, they have to develop means to identify them and erect missing defensive barriers once they've been identified. These goals can not be accomplished without continuous safety endeavour across all levels of the airline, from the line pilot or ground staff up through top management.**

# CHAPTER 4

# SAFETY SURVEY DESIGN AND INTERVIEW

"Safety is work that is more than opportune, it is imperative."
------- *Victor Hugo*

## 4. Overview

Chapters 2 and 3 provide an illustration of how accidents are identified and analysed. They probe the perceptions of factors contributing to accidents and the implication of safety culture to root out the underlying causal factors.

The chapter begins with an illustration of why a safety survey is essential in accident prevention and how it was conducted to reach the optimal goal. Then, it indicates that the reason for selecting Taiwan and Asia as research subjects is to understand the regional situation to deal with regional safety issues. The author goes on to discuss the methodology used in the research, together with its advantages and disadvantages. In the final sections, sampling, distribution procedures and a summary of the general results obtained from the questionnaire and interview surveys are depicted.

## 4.1 Conducting a safety survey

### 4.1.1 Fundamental principles of a safety survey

A safety survey is essentially used to review the extent in satisfaction of aviation operations and to diagnose their problems if they appear or are suspected. Figure 4.1 shows the three essential methods of hazard identification: Safety surveys, hazard/incident reporting and investigation, and accident investigation. Among them, a safety survey is the most cost-effective and flexible hazard identification method. It can be done at any time and in any place; it can include all the employees throughout an organisation, or focus on a particular area of operations or facilities. Unlike investigation, a safety survey makes people feel more comfortable in revealing their opinions and observations without holding back. Identifying hazards in advance, it enables airline and safety management to take proactive action to eliminate or avoid their occurance.

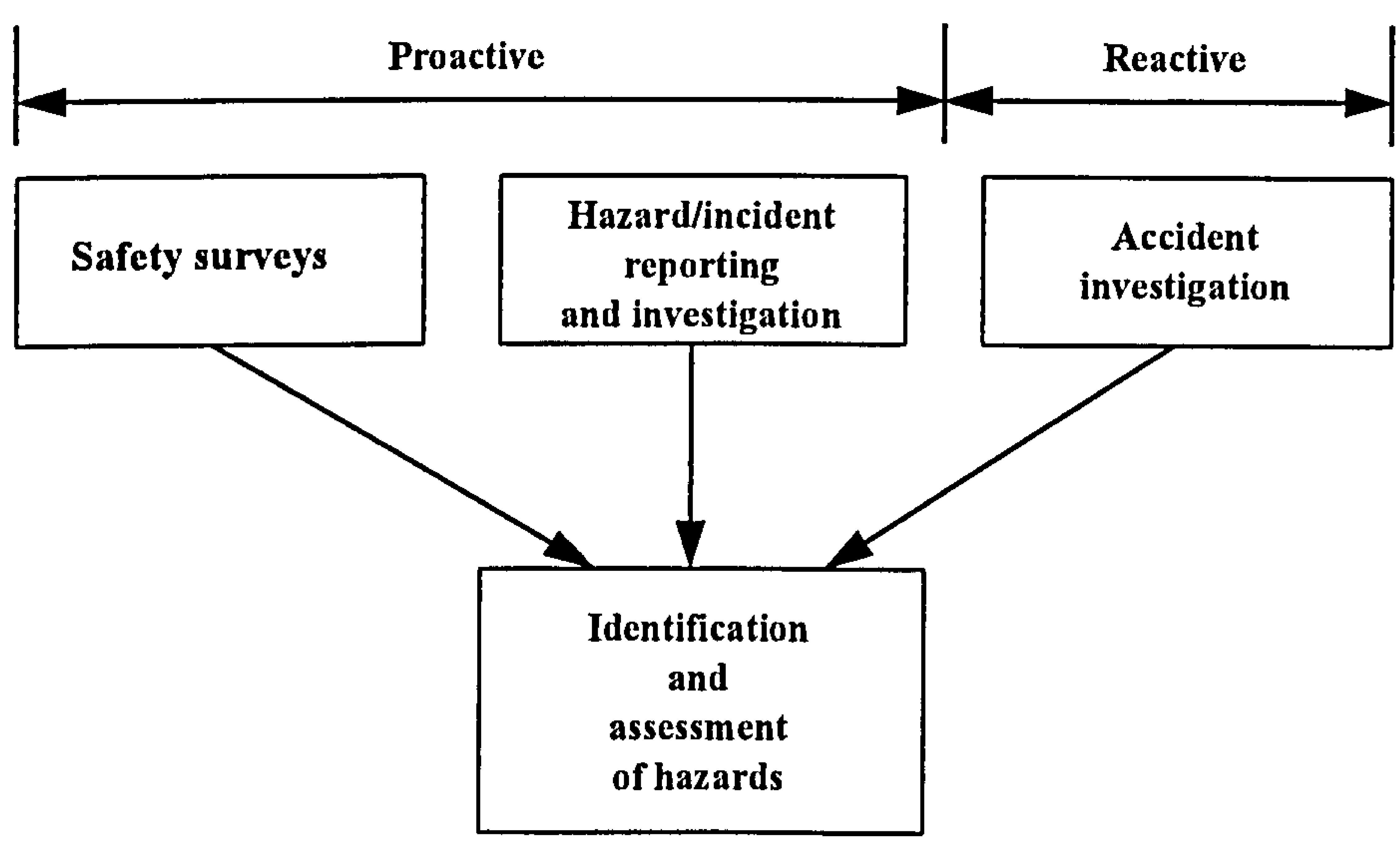



**Figure 4.1 The Three Essential Methods of Hazard identification**

### 4.1.2 Aim of the safety survey

From the discussions in Chapters 2 and 3, it is known that accidents usually result from multicausal factors, and that a high proportion of aviation accidents and incidents are the result of human-factor errors. Nevertheless, it is also realised that many accident causes might be rooted in organisational issues and the role of management. Identifying the failures or weaknesses in an organisation's safety management system could, therefore, yield significant benefits in aviation safety. These benefits might include better understanding of an organisation's existing safety management (e.g. organisation structure, corporate culture, resource availability, the quality of training) and permitting effective formulation of priorities, policies, procedures and tasks by evaluating sufficient feedback gained from line pilots.

As mentioned in Chapter 1, universal solutions in aviation safety are not practical to regions with different cultures; Thus regional solutions are needed. The main study, designed to probe regional situations, was conducted to better understand airline safety management in Asia and, then, make a closer study of one of the Asian air-travel booming countries, Taiwan. The airline safety management survey in the study aims to:

- investigate pilots' perception of airline safety management
- better understanding of the underlying situation
- compare the difference of attitude or perception regarding airline safety management between Captains and First Officers, *Ab-initio* trained pilots and military trained pilots
- look at the impressions held by of the pilots and CAA operation officers about the role of the aviation regulatory authority on airline safety

## 4.2 A brief introduction to air transport in Taiwan

Due to rapid economic growth, commercial aviation throughout Asia is experiencing an unprecedented boom. Taiwan's carriers exemplify the current situation.

The number of airlines presently operating in Taiwan has grown from five to ten airlines in the past six years. Of these, eight operate regional scheduled flights and two operate international scheduled flights. In 1985 there were about a dozen flights a day between the two largest cities, Taipei and Kaohsiung. On the Taipei-Kaohsiung route there are 99 flights a day in each direction at present (CAA-Taiwan, 1995). These are operated by aircraft types ranging from the Saab SF340 to the Boeing 767. What is more impressive is the Hong Kong route. There are about 105 passenger flights a week and several Boeing 747 freighter services. International routes are expanding too. Destinations on the route network scatter across US, Japan, South-eastern Asia, South Africa, Australia and Europe. They are undertaken by a varied fleet of wide-body airliners, comprising Airbus A300s and A320s, MD-11s, Boeing 747s and the soon-to-be-in-service Boeing 777s. Figurre 4.1 shows traffic growth over the last ten years.

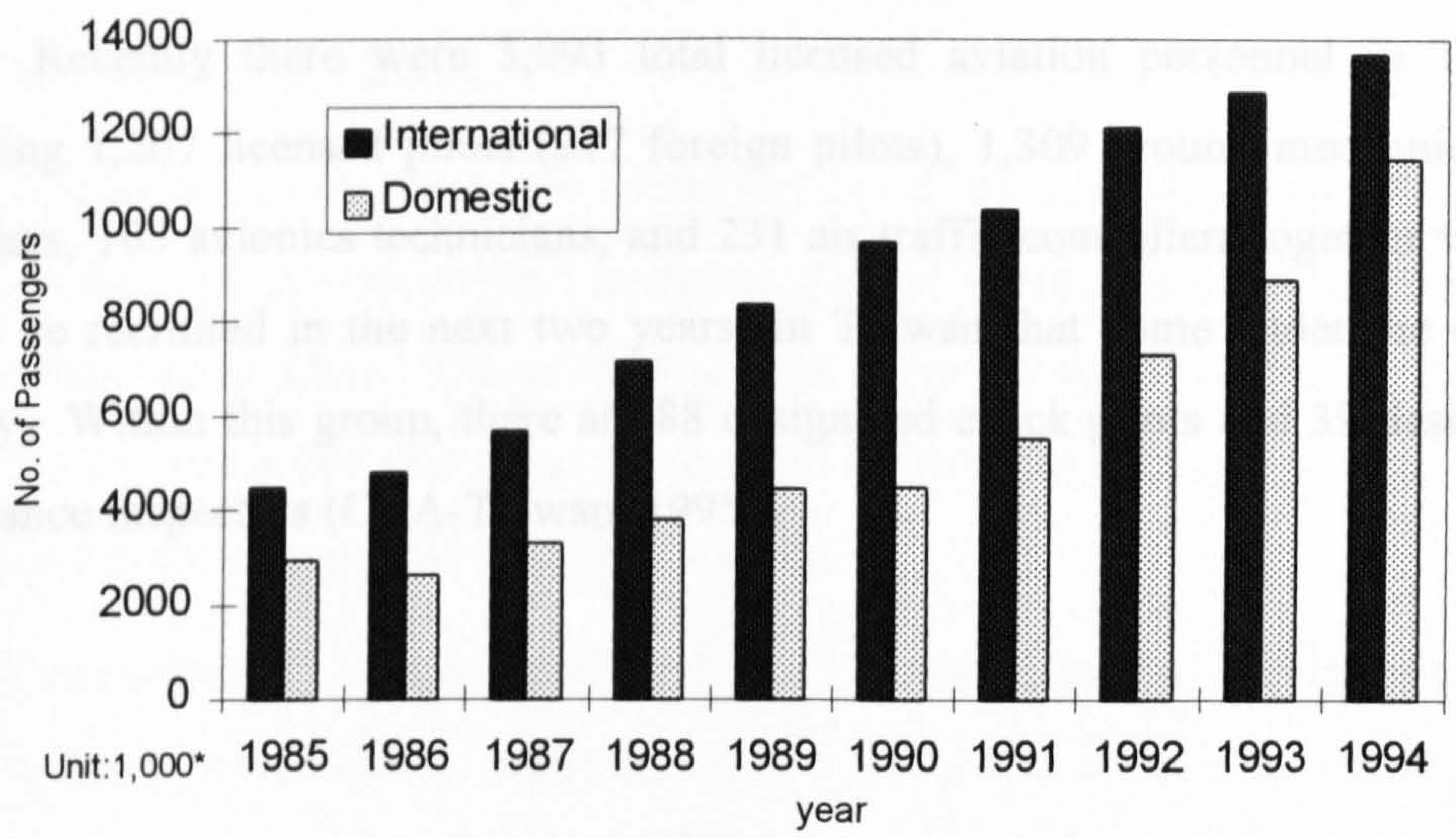



**Figure 4.2 Teeming Taiwan Air Transport**

Source : CAA-Taiwan

* excluding transit passengers.

The reasons for this unprecedented boom in air travel in Taiwan are journey time, deregulation, and the potential establishment of a direct air link with mainland China.

The country's only motorway, linking the capital Taipei in the north to Kaohsiung in the south, is overloaded and the journey time for the distance of 350km is around four hours. In comparison, the flight time by jet is merely 35 minutes. Another major factor was the decision by the government in 1987 to permit open sky, boosted to which was another decision to permit Taiwan residents to visit mainland China in the same year. As all Taiwanese visiting the mainland have to travel via Hong Kong, many of the scheduled flights on the 70 minute journey are operated by Boeing 747s. In addition, the operators expect the approval of a direct air link to the mainland in the near future, so that a number of new carriers have been formed and many orders for new aircraft[17] signed in order to compete with others for the potentially huge market for the next twenty years.

In the past eight years, the number of aircraft has grown from 65 to 156 airworthy aircraft (comprising about 25 fixed wing types, ranging from PA-31 to B-747, and 7 helicopter types). Some additional aircraft are registered, but are not airworthy at present. The licensed pilot population has grown from 314 to 1,207 during the same period. Recently there were 3,093 total licensed aviation personnel in Taiwan, comprising 1,207 licensed pilots (217 foreign pilots), 1,309 ground mechanics, 243 dispatchers, 103 avionics technicians, and 231 air traffic controllers together with 42 more to be recruited in the next two years) in Taiwan that come under the CAA's authority. Within this group, there are 88 designated check pilots and 39 designated maintenance inspectors (CAA-Taiwan, 1995).

[17] Taiwan's Civil Aviation Authority has ruled that the country's airlines are not permitted to buy second-hand aircraft, and it is understood that aircraft over 20 years old will not be permitted to operate in the near future.

## 4.3 Method general overview

The term "survey" is used in a variety of ways, but commonly refers to the collection of standardised information from a specific population. The target population of this safety survey is the airline pilot. The procedure of the safety survey was carried out in four stages: the initial qualitative interviews, the questionnaire construction and pilot stage, the main questionnaire study, and finally the data collection and analysis stage. The following sections give a detailed description of each stage in the research process.

### 4.3.1 Methodological considerations

Based on the degree of structure or formality, surveys are commonly divided into three types: Structured, semi-structured and unstructured surveys (Hague, 1993).

1. *Structured.* In structured surveys, the questions, their wording, and their sequence are fixed and are identical for each respondent. Most of the questions have predefined answers and there will be little latitude for a respondent to stray beyond them. This ensures that any differences between responses are attributable to individual differences and not to variations in the survey.

2. *Semi-structured.* This type of survey has a mixture of questions with predefined answers as well as those where the respondent is free to say whatever he likes. The semi-structured survey is more flexible than its highly structured counterpart and there is likely to be more probing to find out the reasons for certain answers.

3. *Unstructured.* In this type of informal, or depth survey, the questions are not prespecified. Commonly, the researcher used a checklist of questions to assist the respondents to state their experiences, their opinions and attitudes.

Of the variety of survey approaches available, the major self-reported ones include interviews and questionnaires.

The interview survey is a kind of purposeful conversation. It is a flexible and adaptable way of finding things out. All interviews require careful preparation; it is time-consuming. The interview session itself varies in length, but in general it takes 30 to 60 minutes or more to gather valuable data. Considerable skill and experience are necessary for the interviewers to obtain co-operation from potential interviewees as well as to control and close the interviews. In addition, visits need to be arranged and confirmed, appointments need rescheduling to cover absences, notes need to be written up, and subsequent analysis requires even more time.

*Face-to-face interviews* allow the interviewer to modify his line of enquiry or clarify any misunderstandings; they enable the interviewer to probe on specific questions; they encourage co-operation and rapport; and they allow the interviewer to make a truer assessment of what the respondent really believes in a way that postal and other self-administered questionnaires cannot. *Telephone interviews* share many of the advantages of face-to-face interviewing: a high response rate; correction of obvious misunderstandings, etc. Other advantages include smaller interviewer effects and a lower tendency towards socially desirable responses. However, the lack of visual cues may cause problems in interpretation.

The format of the *postal questionnaire* may be highly structured or semi-structured. The degree of structure is determined by the inclusion of closed and/or open-ended questions. With closed-ended questions the respondent has to choose from given alternatives or select unrealistic alternatives and the analysis is straightforward. On the other hand an open-ended style enables a more elaborate response and depth of understanding, but it is difficult to code the wealth of qualitative information obtained.

Postal self-completion questionnaires can be completed and returned by a large number of respondents in about the same amount of time that it takes to complete a single interview. The major advantage of postal self-completion questionnaires, particularly if the sample is hard to reach or is dispersed in different countries, is the lower cost in terms of effort, time and money. Checking on the honesty or sincerity of responses may be difficult, but this is compensated for by the provision of anonymity. Anonymity is considered particularly important when the questions demand a considered answer or are so sensitive that the interviewees may not give a true answer in the presence of an interviewer. The most serious disadvantage is identified as the low response rate. Nachmias and Nachmias (1976) note that the typical response rate for a face-to-face questionnaire is about 95 percent, whereas that for a postal questionnaire is between 20 and 40 percent. Nevertheless, a well-constructed questionnaire needs less time to code and analyse responses, particularly when open-ended questions are kept to a minimum and when computer coding or analysis is available.

### 4.3.2 Structure of the chosen methodology

Questionnaires and interviews are usually used in safety surveys to determine if a particular facility or operation contains hazards. Interviews in particular may elicit information which cannot be obtained from self-completion questionnaires.

Table 4.1 summarises the three different classifications of survey and shows the types of survey approaches the author adopted in the study.

**Table 4.1 A Classification of Self-reported Survey**

| Type of Survey | Survey Approach | The Author's Choice |
|---|---|---|
| Structured | Postal questionnaire | ✓ |
| | Face-to-face interview | |
| | Telephone interview | |
| Semi-structured | Postal questionnaire | |
| | Face-to-face interview | ✓ |
| | Telephone interview | ✓ |
| Unstructured | Visit interview | |
| | Group discussions | |
| | Depth telephone interview | |

The decision was made to use questionnaires for the major part of the Airline Management Safety Survey, while face-to-face and telephone interviews were employed to complement questionnaires. Table 4.2 summarises the advantages and disadvantages of the chosen methodology.

**Table 4.2 Advantages and disadvantages of the chosen methodology**

| | Advantages | Disadvantages |
|---|---|---|
| Face-to-face Interview | • Correction of misunderstanding<br>• Encouragement to participation and involvement<br>• A high response rate | • Interviewer effects and bias<br>• Less forthcoming or open responses<br>• Social desirability response bias<br>• Time-consuming |
| Telephone Interview | • A high response rate<br>• Correction of misunderstandings<br>• Smaller interviewer effects<br>• A lower tendency towards socially desirable responses<br>• Low cost, short time and less effort | • Lack of visual cues for interpretation. |
| Postal Questionnaire | • A large sample<br>• Large amounts of data<br>• Low cost, short time and less effort<br>• Anonymity<br>• Data standardisation. | • A low response rate<br>• Undetectability of ambiguities and misunderstanding |

Although a postal questionnaire is not the most effective data collection method in terms of quality of data or response rate, it is efficient to reach a large sample of the pilots who were "mobile" all the time due to the nature of their occupation.

In order to improve the response rate, a number of techniques were adopted in this research programme. They are as follows:

- The questionnaire was printed on coloured paper in order to make it appear more interesting;
- Questionnaire was pretested to ensure that wording and instructions were clear, and that the length of questionnaire was compact enough to encompass all the key questions and not to bore the respondents;
- The researcher tried addressing to a named person if possible;

- A covering letter was enclosed to inform the participants of the purpose and importance of the research, to assure confidentiality and to encourage a reply;
- A stamped addressed envelope for return of the questionnaire was enclosed;
- A follow-up letter was sent to thank them for their help and offer an abstract of the findings.

It is hoped that the use of both interviews (face-to-face and telephone) and questionnaires as complementary approaches avoids the shortcomings of either, and strengthens the validity and reliability of the data obtained.

## 4.4 Development of the survey instrument

### 4.4.1 The design of the postal questionnaire

Considering the necessity of generating a series of items for inclusion in the survey and acquiring a broad understanding of the airline operating environment, informal interviews were first conducted with management pilots and some safety professionals to elicit information about the possible factors relevent to airline safety management (Interviewees are listed in Appendix B). From these meetings, ideas for questionnaire design and content were noted and some were later implemented in the final questionnaire.

The questionnaire consisted of two parts: the first contained questions about the pilots' biographical details; the second contained questions about the pilots' opinions on airline safety management. Questions in the first part asked about pilots' current crew position, number of years in professional flying, source of initial training, and their airline. Questions in the second part comprised seven sections addressing: organisational structure; management styles; organisational culture; operating standards and training; resource availability; organisation effectiveness; and the role of the aviation regulatory authority. At the end of this part respondents were given space for freehand comments.

It was noted that the five-point Likert scale was widely used in attitude measurement, but after consideration of the neutral or modest bias found in some Asian countries (Stening & Everett, 1984; Chun, Campbell & Yoo, 1974; Zax & Takahashi, 1967)[18], a six-point scale was developed to make respondents take sides rather than revert to a neutral answer. The pilots were requested to state their agreement on the six-point scale ranging from "Strongly Disagree", "Disagree", "Slightly Disagree", "Slightly Agree", "Agree" to "Strongly Agree". Each of these questions also contained an "I don't know" option, used by subjects who did not know the situation, or did not want to express an opinion on a particular issue.

### 4.4.2 Pre-testing of the postal questionnaire

Due to the restraints of geography and time, it was decided that the pilot survey would not entail the standard procedure of carrying out a mail shot with members of the target population. Instead the nearest and most convenient persons were chosen to act as respondents for the pilot test. The questionnaire was completed and criticised by individuals who had skills in either questionnaire design and research methods, or skills and experience in aviation. Some of the individuals used were the multinational pilots attending short courses at Cranfield University. The others were Taiwanese airline pilots who were training at the British Aerospace Flying Training Centre in Woodford.

The pilot test was conducted in order to determine whether or not the questions and instructions were clear and readily understood. The author was available to answer queries about the questionnaire and to observe the sample subjects when they filled it in so that any possible misunderstanding of the questions could be avoided or corrected. This procedure and respondents' comments led to minor modifications of some questions. One major suggestion from Chinese respondents in the pilot study was to include a translation into Chinese. When the final questionnaire was

[18] A less extreme response style, a tendency to overuse the mid-range of a scale, has been linked with cultural norms of modesty and caution in Asian cultures. In contrast, some Mediterranean romance cultures appear to overuse the extremes of the scale to demonstrate sincerity (Hui & Triandis, 1989).

administered, a Chinese translation was available to respondents. These final copies used for the study can be found in Appendix C and D.

### 4.4.3 The design of the interview questionnaire

For the purpose of this study a multi-method approach was considered appropriate for two reasons. Questionnaires helped to examine the differences between respondents on a general basis, and interviews, as a complement to questionnaires, offered the freedom to discuss the situations with a pilot and to raise specific queries concerning the influence on airline safety management.

To encourage frankness, anonymity was provided for the pilots, both for themselves and for the airline which they worked for. The main considerations in selecting individual interviews rather than group interviews were that the pilots were usually hard to reach due to their flying schedules, and that many pilots wished for confidentiality when discussing their company's policies and situation, or personal experience on safety issues. On most occasions, face-to-face interviews were done in the meeting rooms at the interviewees' company. When face-to-face interviews were unlikely to be arranged, telephone interviews were used. All respondents had a very positive attitude towards this research.

The interview questionnaire comprised two parts. The first part, which consisted of four questions, asked about pilots' current crew position, source of initial training, number of years working for the company, and the aircraft type they flew at that time. The second part contained topics about company management; pilot selection, training and operation standard; company resource management; the role of CAA; cockpit communication problems; and flying experiences with multinational crews. The interview questionnaire included both open and closed questions with English and Chinese versions (see Appendix F).

### 4.4.4 Interview characteristics

The interview was semi-structured, so that the sequencing of questions, the amount of time and attention given to different topics were guided and modified by the interviewee's responses. It depended on whether an interviewee's previous answer covered the content of the planned questions, whether there was a natural circumstance for the interviewer to ask those questions, or if the interviewee felt relaxed to talk about his experience. Not all questions were asked in every interview. Some questions which seemed inappropriate with a particular interviewee were left out. The interviewer was cautious about not putting pressure on interviewees so that they could talk freely and be at ease. The actual interview session varied in length from forty minutes to four hours.

There are two main features in these interviews. The first is that the interview is semi-structured rather than completely open. This means that all the interviews with the same group of interviewees started with the same question. The intention was to let them say anything unexpressed in the questionnaire, especially about their attitudes, flying, and safety experiences.

The second feature is that the interview became a resource for suggestions. Interviewees naturally provided some suggestions to problems posed, or sought advice and suggestions to problems which concerned them. This was another kind of two-way communication. Many interviewees, especially the First Officers, expressed a wish for more opportunity for this kind of discussion.

## 4.5 Methods of interpreting the results

### 4.5.1 Method of interpreting the postal questionnaire

A comparison was made between Captains and First Officers, between military-trained and *Ab-initio* trained pilots, and between international-airline and regional-airline pilots. The significance of any notable differences in responses were statistically tested using Chi-Square. Differences were assumed to be significant if there were at least five in one hundred possibility that the differences were due to chance ($p<.05$).

To be a valid test of significance, chi-square usually requires the most expected frequencies ($f_e$'s) be 5 or larger. This is always true for a two-by-two table. If larger than a two-by-two table, a few exceptions are allowed as long as (a) no $f_e$ is less than one and (b) no more than 20% of the $f_e$'s are less than 5 (Mark, 1995).

In the study, the tables are two-by-six tables. When any $f_e$ was less than one and/or more than 2 $f_e$'s were less than 5, the author modified the table by collapsing or combining categories until all $f_e$'s satisfy the size criteria.

### 4.5.2 The process of selecting from the interview data

Qualitative data obtained from the interviews was not immediately accessible for analysis as quantitative data, but required to be selected and systematically analysed in order to draw valid meaning from it. The qualitative data, though difficult to analyse, was full of rich descriptions and comments from the live experiences of the interviewees. Moreover, it was useful in supplementing and illustrating the quantitative data obtained from the questionnaire survey.

In order to generate trustworthy results, there were three stages in analysing the interview data: Data reduction, data display, conclusion drawing and verification. At the first stage, the author listed the seven topics which revealed the major interest or the discussion focus in the interview for examining the interview data. Data not significant for the purpose of this research was left out. At the second stage, the author did not transcribe every word of an interview, but selected remarks and comments related to the seven topics. The information was consequently organised and assembled into a more accessible form so that it was easier to draw justified conclusions. The final stage was conclusion drawing and verification. The attempts at this stage were to locate recurring patterns, make contrasts/comparisons and generate meaning from the findings. The conclusions were consequently weighted with evidence gained from other studies to check their validity.

## 4.6 Sampling strategy and limitation

The negotiation of access is a continuous and laborious process. It is relatively more difficult to gain access in countries or regions with poorer safety records than those with better safety records, because these countries or regions tend to be more conservative and reluctant to have "extra work".

The study, taking place in conservative environment, encountered great difficulty in clearing official channels for permission to carry out the study. It took much time for the author to contact the managers and discuss the study with them in order to gain access. Even after approval was obtained, there were further problems. In one instance, the middle manager hesitated to carry out what he had agreed to because his superior did not support and accept the study. In an other case, the manager in a flight operations department agreed to have the study carried out, but the other manager in the safety department was afraid of too many sensitive issues being exposedby the research. Given these circumstances, the response rates consequently turned out to be much lower than expected. The withdrawing from the study at a later stage and the occurrence of conflicts not possible to foretell. This indicates the importance of flexibility in real world research and the possibility of sampling bias. As experienced researchers stress, the contest between what is theoretically desirable and practically possible must be won by the practical.

The respondents of the questionnaire could be divided into three groups: Taiwanese pilots, Asian management pilots, and Asian CAA officers.

The sample of the Taiwanese pilots who participated in the study was from six out of the ten scheduled airlines in Taiwan. As mentioned earlier, the author encountered considerable difficulty in obtaining the co-operation of the airlines, and it was impossible to obtain the assistance of Taiwan's airline pilot association because it has only just been established in May of 1995 and posessed only a few members to be undertaken.

The questionnaire was also distributed to the Asian management pilots in twelve airlines as listed in Appendix G, and sent out to Asian CAA standards and safety officers in eight countries. The names of these CAA officers came from ICAO Document 7604. Although the proportion of Asian pilots and CAA officers was unrepresentative of the flying and CAA population, the problems encountered in sampling subjects led to the decision to accept that the sample achieved would contain some bias.

## 4.7 Distribution procedure

In the Taiwan's case, the questionnaire survey was taken or sent to the representative at each participating airline in sealed envelopes and distributed to the pilots by the airline administrator. Included with the questionnaire was a covering letter from the author, a memo from the flight operations manager or safety manager of each airline, and a postage paid addressed envelope. The covering letter explained the purpose of the research, ensured its confidentiality and anonymity of all responses. The memo confirmed that the airline had approved the research programme and invited flight crew to participate in the study on a voluntary basis only. The pre-addressed stamped envelope enabled the direct return of the completed information to the author.

As to the groups of Asian management pilots and CAA standards and safety officers, the distribution procedure was similar to that employed for the Taiwanese pilots. The major differences were that the questionnaire was mailed directly to the pilots, and that in order to increase response rates, a reminding letter was sent out three weeks after the questionnaire had been distributed. Once again the questionnaire was accompanied by the covering letter used in the Taiwanese pilots case and a pre-addressed envelope for the return of the completed questionnaire to the author.

## 4.8 Results

### 4.8.1 Response rate details

The study includes two major parts: postal questionnaire survey and face-to-face interview survey. Of the 949 questionnaires distributed, 323 were completed and returned in time for analysis, representing a response rate of 34%. With respect to interviews, 32 Taiwanese pilots and 5 expatriate Captains[19] were interviewed, and all of the interview questionnaires were analysed. A detailed account of the response rates of the postal and interview surveys is given in Table 4.3.

**Table 4.3 Response Rates of the Postal and Interview Surveys**

| Administration of Questionnaire | Subject | Sent | Received | Response Rate |
|---|---|---|---|---|
| Postal | Pilot study | N = 24 | n = 22 | 91.7% |
| | Taiwanese pilots | N = 685 | n = 233 (245) | 34.0% |
| | Asian MGT pilots | N = 186 | n = 46 (53) | 24.7% |
| | Asian CAA officers | N = 54 | n = 22 | 40.7% |
| Interview | Taiwanese pilots * | N = 37 | n = 37 | 100.0% |

* Including five expatriate Captains

Under the "received" column, the numbers in parentheses are the actual returned copies of questionnaires, and the numbers without the parentheses represent the valid copies of questionnaires. The due date for Asian management pilots and Asian CAA officers to return their completed questionnaires was the longest, about three months after the questionnaires were mailed. This was decided, after consideration was given to the fact that they were not easy to locate because of their flying schedules, that the postal systems in these Asian countries differed, and that the delivery time would be extended due to the need to translate the English-written address to the language of their own.

The overall response rate of 33% was considered satisfactory and was consistent with the tendency for postal surveys to achieve a response rate of between 20% and 40%.

[19] According to Regulations of Operations of Civil Air Transport Enterprise -Taiwan, Chapter 5, Article 62, and Region of Airman Rating and Certification, Chapter 6, Article 96, airlines are allowed to recruit expatriate Captains only.

Merrit (1995) stated that according to the NASA/FAA/University of Texas group's experience, the magic number for the larger airlines is 20 percent while it is 40 percent for smaller ones. Each questionnaire was coded for computer analysis and entered into the personal computer using the SPSS statistical analysis package.

### 4.8.2 Flying experience and personal details

A breakdown of the response according to the respondent's position is presented in Table 4.4. There were 94 Captains and 139 First Officers included in the main study. Of the 233 respondents, 42.5% were from international airlines and 57.5% were from regional airlines. Regional airlines refer to those operating domestic and/or intra-Asian flights, while international airlines are those who offer services on international routes.

Of the total respondents, 12.0% were the international-airline Captains, 28.3% were the regional-airline Captains, 30.5% were international-airline First Officers, and 29.2% were regional-airline First Officers.

**Table 4.4 Breakdown of Response According to Airlines and Current Position (Taiwanese Pilots)**

| Position | International Airlines | Regional Airlines | Total |
|---|---|---|---|
| Captain | 28 (28.3%) | 66 (49.3%) | 94 (40.3%) |
| First Officer | 71 (71.7%) | 68 (50.7%) | 139 (59.7%) |
| Total | 99 (42.5%) | 134 (57.5%) | 233 (100%) |

Chi-square goodness of fit analyses were performed to determine whether the distribution of responses according to position was significant for the target population. The observed and expected frequencies for each cell are presented in table 4.5. The results indicated that the obtained chi-square was significant at the 0.01 level. It can therefore be concluded that the distribution of responses between Captains and First Officers are different from the distribution of ranks in the population from which they were drawn.

**Table 4.5 One-way Chi-square to Examine the Distribution of Respondents According to Position: Observed and Expected Cell Frequencies**

| Captains | First Officers |
|---|---|
| Observed freqency = 94 | Observed freqency = 139 |
| Expected frequency = 116 | Expected frequency = 116 |

$p<0.01$, df = 1, $X^2_{obt} = 8.69$

Analysis of the personal data for Taiwanese pilots (n = 233) revealed that the majority of these pilots had been working in civil aviation for 2-10 years, corresponding to 65.7% (see Table 4.6). The highest proportion for the Captains was in the 6-10 year category, whereas the highest proportion for the First Officers was in the 2-5 year category. It seems that their working experience in civil aviation was not relatively short, but up to 79.8 percent of these subjects had worked as pilots in the air force (see Table 4.7).

**Table 4.6 Breakdown of Response According to Current Position and Airline Working Experience (Taiwanese Pilots)**

| Position | Less than 2 years | 2-5 years | 6-10 years | 11-15 years | 16-20 years | More than 20 years |
|---|---|---|---|---|---|---|
| | No. (%) | No. (%) | No. (%) | No. (%) | No. (%) | No. (%) |
| Captains | | 11 (4.8) | 46 (19.8) | 22 (9.4) | 11 (4.7) | 4 (1.7) |
| F/O | 43 (18.4) | 86 (36.9) | 10 ( 4.2) | | | |
| Total | 43 (18.4) | 97 (41.7) | 56 (24.0) | 22 (9.4) | 11 (4.7) | 4 (1.7) |

n = 233

**Table 4.7 Initial Flying Training Background (Taiwanese Pilots)**

| Background | Frequency | Percent |
|---|---|---|
| Military | 186 | 79.8 % |
| *Ab-initio* | 42 | 18.0 % |
| General aviation | 5 | 2.1 % |

n = 233

The percentage of initial training background that the achieved samples revealed was an approximately similar distribution for the population of flight crew in Taiwan. The subjects were, therefore, considered representative.

A breakdown of the response of Asian management pilots and CAA standards and safety officers according to current position and working experience is presented in Table 4.8. More than 50% of the Asian management pilots had 16-20 year working experience and about 40% of the sample had been working for more than 20 years in aviation. 28 (60.9%) pilots received initial training in the military, 10 (21.7%) trained at *Ab-initio* scheme, and 8 (17.5%) were from general aviation (see Table 4.9).

On average Asian CAA officers are less experienced. Marginally more than 40% of them were in 16-20 year category and only one of them had more than 20-year working experience. Of the 22 CAA officers, 18 were of either flying or engineering background (see Table 4.10).

**Table 4.8 Breakdown of Response According to Current Position and Working Experience (Asian Management Pilots and CAA Officers)**

| Position | 6-10 years | 11-15 years | 16-20 years | More than 20 years |
|---|---|---|---|---|
| Asian MGT pilot | | 3 | 25 | 18 |
| n = 46 | | 6.5% | 54.3% | 39.2% |
| Asian CAA officer | 5 | 7 | 9 | 1 |
| n = 22 | 22.7% | 31.8% | 40.9% | 4.5% |

**Table 4.9 Original Flying Background (Asian Management Pilots)**

| Background | Frequency | Percent |
|---|---|---|
| Military | 28 | 60.9 % |
| *Ab-initio* | 10 | 21.7 % |
| General aviation | 8 | 17.5 % |

n = 46

**Table 4.10 CAA Working Background (CAA Officers)**

| Background | Frequency | Percent |
|---|---|---|
| Pilot | 10 | 45.5 % |
| Air traffic officer | 3 | 13.6 % |
| Engineer | 8 | 36.4 % |
| Other | 1 | 4.5 % |

n = 22

### 4.8.3 The overall results of the postal questionnaire

The means and standard deviation for each of the 34 statements are presented for each group in Tables 4.11 and 4.12. An examination of these tables indicated that there was some variability in response to each question (i.e. most standard deviations were greater than one). Nevertheless, both Taiwanese and Asian management pilots shared the same opinions on statements 32 and 8. Most of them disagreed that the CAA's investigators were qualified to the level of advanced technology aircraft, and that the reward system for safety in the airline was well organised.

**Table 4.11 Means and Standard Deviation of Responses to Each Question ( Taiwanese pilots )**

| | All pilots mean ( s.d.) | Captain mean ( s.d.) | First officer mean ( s.d.) |
|---|---|---|---|
| 1. Significant expansion in the scale of the airline operations. | 5.45 (0.83) | 5.48 (0.83) | 5.43 (0.83) |
| 2. Functional responsibility for safety is clearly placed. | 4.26 (1.36) | 4.28 (1.40) | 4.25 (1.34) |
| 3. The influence of safety staff is strong. | 3.84 (1.28) | 4.03 (1.27) | 3.70 (1.29) |
| 4. The position of safety staff in the company's hierarchy is appropriate. | 3.69 (1.40) | 3.54 (1.33) | 3.80 (1.44) |
| 5. Top management is dedicated to supporting safety policies and events. | 4.19 (1.32) | 4.33 (1.34) | 4.10 (1.30) |
| 6. Operations managers are strongly involved in the safety events. | 4.48 (1.23) | 4.54 (1.29) | 4.43 (1.19) |
| 7. The safety staff have direct access to top management. | 4.32 (1.21) | 4.48 (1.22) | 4.19 (1.19) |
| 8. Reward system for safety is well organised. | 3.09 (1.33) | 3.05 (1.43) | 3.11 (1.26) |
| 9. The safety inspection program is satisfactory. | 3.65 (1.13) | 3.67 (1.19) | 3.63 (1.10) |
| 10. The perception of safety is good in the company. | 4.11 (1.07) | 4.19 (1.17) | 4.05 (1.01) |
| 11. Channels for communication are accessible in the company. | 3.13 (1.14) | 3.34 (1.24) | 2.98 (1.04) |
| 12. Flight and ground crews co-ordinate well . | 3.73 (1.09) | 3.90 (1.05) | 3.62 (1.11) |
| 13. The company encourages voluntary safety reports from crews. | 3.93 (1.23) | 3.91 (1.20) | 3.94 (1.26) |
| 14. Crews are willing to report hazards/incidents. | 3.89 (1.20) | 3.95 (1.28) | 3.85 (1.14) |

| | All pilots | Captain | First officer |
|---|---|---|---|
| | mean ( s.d.) | mean ( s.d.) | mean ( s.d.) |
| 15. Crews are willing to report hazards/incidents. | 3.89 (1.20) | 3.95 (1.28) | 3.85 (1.14) |
| 16. The company makes strong efforts to standardise checklists and manuals in accordance with its policy. | 4.94 (1.03) | 4.94 (1.11) | 4.94 (0.97) |
| 17. The selection criteria for flight crews are high. | 3.95 (1.23) | 4.09 (1.31) | 3.86 (1.16) |
| 18. The quality of recurrent training is very good. | 4.16 (1.19) | 4.16 (1.32) | 4.17 (1.09) |
| 19. The working experience of qualified crew members is high. | 4.14 (1.17) | 4.46 (1.25) | 3.92 (1.06) |
| 20. Human factors training is effective. | 3.40 (1.32) | 3.26 (1.54) | 3.48 (1.16) |
| 21. The company maintains incident/accident data very well. | 3.79 (1.17) | 3.71 (1.24) | 3.85 (1.13) |
| 22. The company enthusiastically participates in the aviation safety organisations and meetings. | 4.04 (1.33) | 3.91 (1.33) | 4.13 (1.35) |
| 23. The company provides very good quality safety-related information. | 4.05 (1.25) | 4.00 (1.33) | 4.08 (1.19) |
| 24. The company has invested a lot in safety improvement. | 3.54 (1.45) | 3.25 (1.54) | 3.74 (1.36) |
| 25. The safety criteria in the company are strict. | 3.94 (1.50) | 3.87 (1.62) | 3.98 (1.41) |
| 26. The company handles emergency situations effectively and efficiently | 3.59 (1.30) | 3.56 (1.55) | 3.61 (1.10) |
| 27. The company is proud of its safety record. | 4.14 (1.62) | 4.07 (1.74) | 4.19 (1.53) |
| 28. Image of the company's overall service is very good. | 4.04 (1.53) | 3.84 (1.55) | 4.18 (1.50) |
| 29. The CAA's pace of response to technological change is good. | 3.24 (1.23) | 3.32 (1.29) | 3.20 (1.19) |
| 30. The CAA's follow-up to check compliance with its safety standards is good. | 3.31 (1.18) | 3.45 (1.33) | 3.21 (1.06) |
| 31. The CAA's capacity to guide effectively the adequate training of airlines is good. | 3.19 (1.19) | 3.51 (1.25) | 2.98 (1.10) |
| 32. The CAA provides adequate safety information to airlines. | 3.35 (1.06) | 3.54 (1.18) | 3.23 (0.96) |
| 33. The CAA's investigators are qualified to the level of advanced technology aircraft | 2.49 (1.23) | 2.67 (1.31) | 2.37 (1.16) |

**Table 4.12 Means and Standard Deviation of Responses to Each Question ( Asian Management Pilots and CAA Officers )**

| | Asian MGT pilot | CAA officer |
|---|---|---|
| | mean ( s.d.) | mean ( s.d.) |
| 1. Significant expansion in the scale of the airline operations. | 5.35(1.15) | 5.46 (1.39) |
| 2. Functional responsibility for safety is clearly placed. | 4.63 (1.24) | 4.23 (1.34) |
| 3. The influence of safety staff is strong. | 4.48 (1.17) | 3.86 (1.04) |
| 4. The position of safety staff in the company's hierarchy is appropriate. | 4.96 (1.28) | 4.15 (1.04) |
| 5. Top management is dedicated to supporting safety policies and events. | 4.67 (1.16) | 4.18 (0.80) |
| 6. Operations managers are strongly involved in the safety events. | 4.45 (1.19) | 4.28 (1.37) |
| 7. The safety staff have direct access to top management. | 5.07 (1.28) | 4.45 (1.00) |
| 8. Reward system for safety is well organised. | 3.28 (1.30) | 4.15(1.14) |
| 9. The safety inspection program is satisfactory. | 4.05 (0.96) | |
| 10. The perception of safety is good in the company. | 4.74 (1.03) | 4.55 (0.91) |
| 11. Channels of communication are accessible in the company. | 4.41 (1.18) | 4.50 (1.05) |
| 12. Flight and ground crews co-ordinate well. | 4.17 (1.16) | 4.25 (0.44) |
| 13. The company encourages voluntary safety reports from crews. | 4.50 (1.33) | 4.59 (0.73) |
| 14. Crews are willing to report hazards/incidents. | 4.28 (0.96) | 4.05 (1.32) |
| 15. The company makes strong efforts to standardise checklists and manuals in accordance with its policy. | 5.54 (0.59) | 4.55 (1.10) |
| 16. The selection criteria for flight crews are high. | 4.91 (1.23) | 4.32 (0.65) |
| 17. The quality of recurrent training is very good. | 4.92 (0.83) | 4.64 (0.66) |
| 18. The working experience of qualified crew members is high. | 5.02 (0.86) | 3.91 (1.02) |
| 19. Human factors training is effective. | 4.13 (1.33) | |
| 20. The company responds well in terms of change in policies and procedures after any incident/accident happened. | 5.02 (1.24) | |

| | Asian MGT pilot | CAA officer |
|---|---|---|
| | mean ( s.d.) | mean ( s.d.) |
| 21. The company absorbs safety-related information from the industry well. | 4.61 (1.18) | |
| 22. The company maintains incident /accident data very well. | 4.46 (1.38) | |
| 23. The company enthusiastically participates in aviation safety organisations and meetings. | 4.41 (1.30) | |
| 24. The company handles emergency situations effectively and efficiently | 4.00 (1.40) | |
| 25. The company is proud of its safety record. | 5.07 (1.14) | |
| 26. Image of the company's overall service is very good. | 4.65 (1.22) | |
| 27. The CAA's pace of response to technological change is good. | 3.43 (1.66) | 3.86 (0.83) |
| 28. The CAA's follow-up to check compliance with its safety standards is good. | 3.48 (1.39) | 4.32 (0.84) |
| 29. The CAA's capacity to guide effectively the adequate training of airlines is good. | 3.28 (1.60) | 4.14 (0.77) |
| 30. The CAA provides adequate safety information to airlines. | 3.07 (1.29) | 4.18 (0.73) |
| 31. The CAA's investigators are qualified to the level of advanced technology aircraft | 2.61 (1.56) | 4.00 (0.69) |

# CHAPTER 5

# AIRLINE SAFETY SURVEY ANALYSIS AND DISCUSSION

" And the man went on to say : The woman whom you gave to be with me. She gave me from the tree and so I ate. "

------- *Genesis 3:12*

## 5. Overview

In this chapter, the results of the postal questionnaire survey of the main study will be analysed and discussed. There are eight sections, each of which summarises the overall results and then compare the differences in terms of crew position (Captains vs. First Officers), flying background (Military vs. *Ab-initio*) and flights operated (International vs. Regional)[20]. All data collected is then divided into positive and negative answers to measure these pilots' agreement and disagreement to the statements in the questionnaire.[21]

Each section also discusses the written comments made by pilots completing the questionnaire as well as the interview transcripts gathered from the interviews with the thirty-seven pilots.

At the end of each section, further discussion will be provided to look in-depth at the findings of each section.

[20] The main study includes two international airlines and four regional airlines. International airlines offer service on international routes, while regional airlines refer to those operating domestic and/or intra-Asia flights.

[21]The term 'Positive' indicates a respondent's favourability towards the attitude object or behaviour in question, in this case indicated by a score of 4-6 (where scales are used). The term 'Negative' reflects unfavourability on the part of respondents towards the attitude object or perception in question. This is indicated by scores of 1-3 (where scales are used) in this study. The term 'don't know' is used to describe respondents who are neither favourably nor unfavourably disposed towards the attitude object or behaviour in question. A score of 8 is attributed to this situation (where scales are used).

## 5.1 The Safety department in an airline's organisation structure

### 5.1.1 Introduction

The structure of an organisation is an indicator of what priorities the organisation has on its activities. In a bureaucratic organisational structure[22], the closer to the top of the pyramid, the more important the department is to the strategy of the company (Crozier, 1964).

This is especially true for safety. The position of the safety department not only is an indirect sign to crews about the importance of safety, but affects the effectiveness and efficiency of communication, co-ordination and use of information.

The first section required pilots to indicate their opinions on statements about the position and influence of safety officers in their airlines. The five statements included in this section are:

1. In the past several years, your company has undergone a significant expansion in the scale of its operations.
2. Functional responsibility for safety is clearly placed.
3. The influence of the safety staff is strong.
4. The position of safety manager or personnel in your company's hierarchy is appropriate.
5. The safety manager / personnel have direct access to top management.

### 5.1.2 Pilots' opinions of safety officer position and influence in the organisation structure

Figure 5.1 illustrates the difference in responses on the five statements. The majority of the pilots agreed on the first and the second statements. Though about half of the respondents gave positive answers on the third and the fourth statements, 39.1% and 45.9% of the pilots expressed their disagreement. As to the fifth statement, most pilots consent that the safety manager / personnel had direct access to top

[22] Unlike the stereotyped description of excessive red tape and procedural delays, a bureaucratic structure is a well-organised collection of offices that combines the efforts of large numbers of people through a system of rules and procedures (Cherrington, D. J. 1994. Organisational behaviour: The management of individual and organisational performance. Allyn and Bacon.).

management. However, the percentage of "I don't know" answers was very high, about 13%.

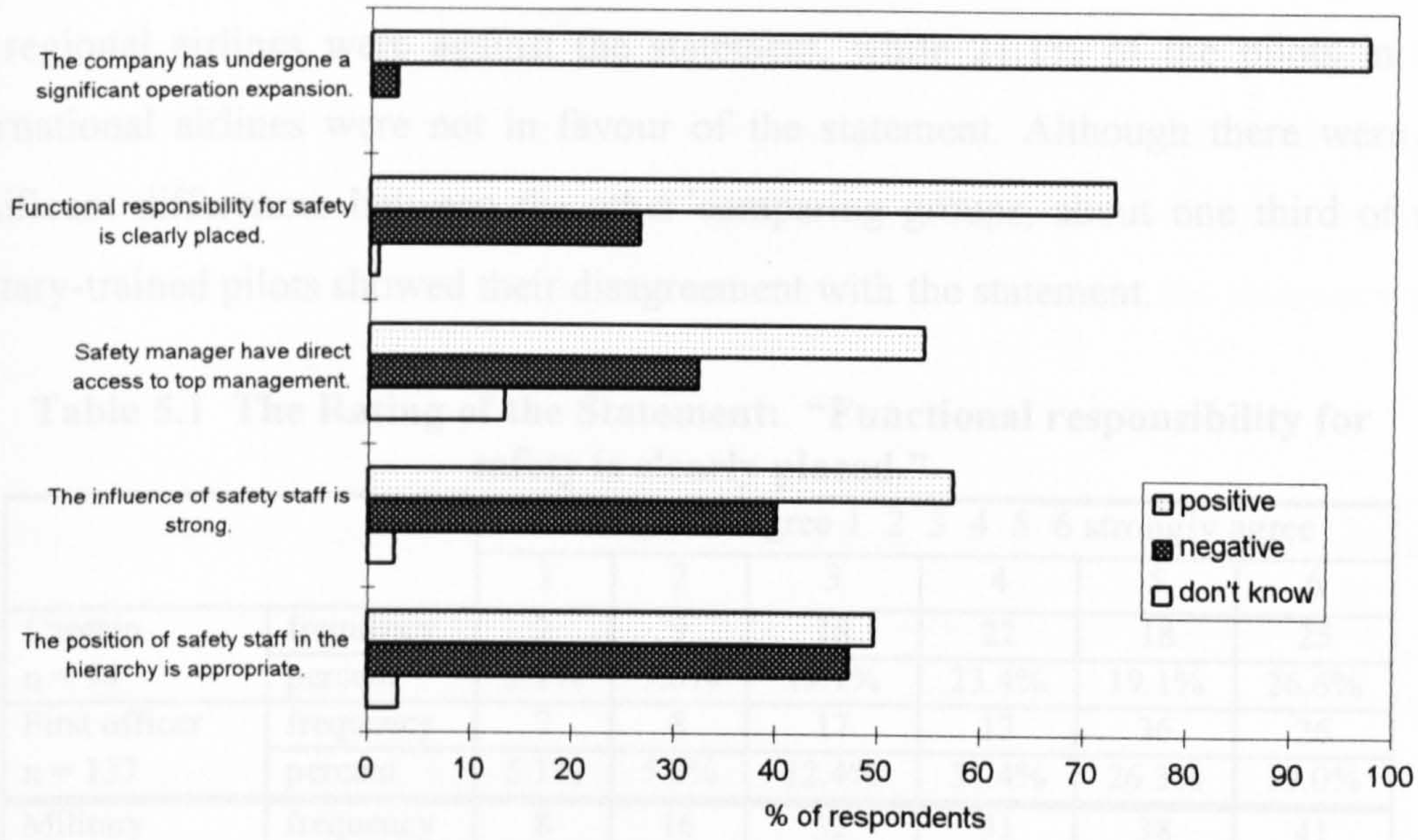



**Figure 5.1 Position and Influence of Safety Officer in the Organisation**

*Placement of functional responsibility* Chi-square revealed that there were significant differences at the .05 level between international and regional airlines regarding the placement of functional responsibility for safety. 30.3% of the pilots in the regional airlines were against the statement, while 21.1% of the pilots in the international airlines were not in favour of the statement. Although there were no significant differences between the other comparing groups, about one third of the military-trained pilots showed their disagreement with the statement.

**Table 5.1 The Rating of the Statement: "Functional responsibility for safety is clearly placed."**

| | | strongly disagree 1 2 3 4 5 6 strongly agree | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Captain | frequency | 2 | 9 | 18 | 22 | 18 | 25 |
| n = 94 | percent | 2.1% | 9.6% | 19.1% | 23.4% | 19.1% | 26.6% |
| First officer | frequency | 7 | 8 | 17 | 13 | 36 | 26 |
| n = 137 | percent | 5.1% | 5.8% | 12.4% | 31.4% | 26.3% | 19.0% |
| Military | frequency | 8 | 16 | 32 | 51 | 38 | 41 |
| n = 186 | percent | 4.3% | 8.6% | 17.2% | 27.4% | 20.4% | 22.0% |
| *Ab-initio* | frequency | 1 | 1 | 3 | 14 | 16 | 10 |
| n = 45 | percent | 2.2% | 2.2% | 6.7% | 31.1% | 35.6% | 22.2% |
| International | frequency | 2 | 7 | 12 | 24 | 34 | 20 |
| n = 99 | percent | 2.0% | 7.1% | 12.1% | 24.2% | 34.3% | 20.2% |
| Regional | frequency | 7 | 10 | 23 | 41 | 20 | 31 |
| n = 132 | percent | 5.3% | 7.6% | 17.4% | 31.1% | 15.2% | 23.5% |

[$x^2_{obt}$ = 12.58, df = 5, p<.05] International vs Regional

*Influence of safety staff* Chi-square revealed that there was a significant difference at the .05 level between Captains and First Officerss. More First Officerss (48.1%) expressed their disagreement on the influence of safety staff than the Captains. There were no significant differences between the pilots in the other two groups. However, military-trained pilots (43.5%) outnumbered *Ab-initio* trained pilots (26.6%) in showing their disagreement on the statement. Moreover, about sixteen percent of the pilots working with regional airlines indicated "strongly disagree" or "disagree" on the statement, whereas only 6.4% of the pilots with international airlines gave such strong negative answers.

*Position of safety manager* Chi-square revealed that there were significant differences between Captains and First Officerss ($p<.05$), between military- and *Ab-initio* trained pilots ($p<.05$), and between international and regional airlines ($p<.01$). About half of the First Officerss disagreed that the position of safety manager was appropriate. There was wide variation between the second and the third groups: 52.5% of the military-trained pilots and 59.1% regional-airline pilots gave negative answers, whereas only 25.6% of the *Ab-initio* trained pilots and 30.8% international-airline pilots reported disagreement.

*Direct access to top management* As seen in Table 5.4, there were no significant differences between these groups regarding direct access to top management. In general, more Captains, *Ab-initio* trained pilots and international-airline pilots gave positive answers to the statement than their counterparts, corresponding to 79.8%, 84.2% and 75.2% respectively. However, the average percentage of the positive responses was not so high, being 67.4% after the 31 pilots giving the "I don't know" answer were included.

**Table 5.2 The Rating of the Statement: "The influence of safety staff is strong."**

| | | strongly disagree 1 2 3 4 5 6 strongly agree | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Captain | frequency | 4 | 6 | 17 | 37 | 16 | 14 |
| n = 94 | percent | 4.3% | 6.4% | 18.1% | 39.4% | 17.0% | 14.9% |
| First officer | frequency | 8 | 9 | 47 | 33 | 23 | 13 |
| n = 133 | percent | 6.0% | 6.8% | 35.3% | 24.8% | 17.3% | 9.8% |
| Military | frequency | 11 | 14 | 54 | 57 | 26 | 20 |
| n = 182 | percent | 6.0% | 7.7% | 29.7% | 31.3% | 14.3% | 11.0% |
| *Ab-initio* | frequency | 1 | 1 | 10 | 13 | 13 | 7 |
| n = 45 | percent | 2.2% | 2.2% | 22.2% | 28.9% | 28.9% | 15.6% |
| International | frequency | 2 | 4 | 26 | 26 | 22 | 14 |
| n = 94 | percent | 2.1% | 4.3% | 27.7% | 27.7% | 23.4% | 14.9% |
| Regional | frequency | 10 | 11 | 38 | 44 | 17 | 13 |
| n = 133 | percent | 7.5% | 8.3% | 28.6% | 33.1% | 12.8% | 9.8% |

[$x^2_{obt}$ = 11.14, df = 5, $p<.05$] Captain vs First Officer

**Table 5.3 The Rating of the Statement: "The position of safety manager or personnel in your company's hierarchy is appropriate."**

| | | strongly disagree 1 2 3 4 5 6 strongly agree | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Captain | frequency | 8 | 12 | 23 | 34 | 14 | 7 |
| n = 94 | percent | 8.5% | 12.8% | 24.5% | 31.9% | 14.9% | 7.4% |
| First officer | frequency | 10 | 9 | 45 | 22 | 26 | 20 |
| n = 132 | percent | 7.6% | 6.8% | 34.1% | 16.7% | 19.7% | 15.2% |
| Military | frequency | 17 | 17 | 62 | 41 | 26 | 20 |
| n = 183 | percent | 9.3% | 9.3% | 33.9% | 22.4% | 14.2% | 10.9% |
| *Ab-initio* | frequency | 1 | 4 | 6 | 11 | 14 | 7 |
| n = 43 | percent | 2.3% | 9.3% | 14.0% | 25.6% | 32.6% | 16.3% |
| International | frequency | 2 | 6 | 21 | 23 | 25 | 17 |
| n = 94 | percent | 2.1% | 6.4% | 22.3% | 24.5% | 26.6% | 18.1% |
| Regional | frequency | 16 | 15 | 47 | 29 | 15 | 10 |
| n = 132 | percent | 12.1% | 11.4% | 35.6% | 22.0% | 11.4% | 7.6% |

[$x^2_{obt}$ = 12.83, df = 5, p<.05] Captain vs First Officer
[$x^2_{obt}$ = 14.33, df = 5, p<.05] Military vs *Ab-initio*
[$x^2_{obt}$ = 23.98, df = 5, p<.01] International vs Regional

**Table 5.4 The Rating of the Statement: "The safety manager/personnel have direct access to top management."**

| | | strongly disagree 1 2 3 4 5 6 strongly agree | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Captain | frequency | 2 | 3 | 13 | 23 | 28 | 20 |
| n = 89 | percent | 2.2% | 3.4% | 14.6% | 25.8% | 31.5% | 22.5% |
| First officer | frequency | 1 | 13 | 14 | 42 | 26 | 18 |
| n = 113 | percent | 0.8% | 11.5% | 12.3% | 37.2% | 23.0% | 15.9% |
| Military | frequency | 2 | 14 | 23 | 55 | 38 | 32 |
| n = 164 | percent | 1.2% | 8.5% | 14.0% | 33.5% | 23.2% | 19.5% |
| *Ab-initio* | frequency | 0 | 2 | 4 | 10 | 16 | 6 |
| n = 38 | percent | 0% | 5.3% | 10.5% | 26.3% | 42.1% | 15.8% |
| International | frequency | 0 | 6 | 10 | 24 | 30 | 15 |
| n = 85 | percent | 0% | 7.1% | 11.8% | 28.2% | 35.3% | 17.6% |
| Regional | frequency | 2 | 10 | 17 | 41 | 24 | 23 |
| n = 117 | percent | 1.7% | 8.5% | 14.5% | 35.0% | 20.5% | 19.7 % |

*Interview results about organisational structure* The safety function's position, in the airline it serves, varies. The interview survey asked several questions about airline safety programs. Only two of the six airlines surveyed had an independent safety position in the company's management structure. In these two airlines, the position was filled by a manager or officers who reported directly to a member of top management (for example, to president, general manager or equivalent). Another four reported to the director of flight operations.

When pilots were asked to whom they would report a safety concern, most (64%) cited the chief pilot or the director of flight operations (or equivalent position) rather than the flight safety officer. Only 6 of 28 (21%) will voice to the flight safety manager or officers. When pilots were asked why they did not report directly to safety officers, explanations frequently offered were, "It is more effective to report to the chief pilot rather than the safety officer." and "You will get no response if you report to the safety officer."

Some impressive points made below are based on interviews or the comments from the postal questionnaire:

> "The Flight Safety Office or Department should be placed at a level higher than Flight Operations Department to ensure its neutrality. Safety-related personnel should be qualified and capable of practising their specialities without being restrained by the Flight Operations Department."
>
> "Safety-related personnel should be competent individuals with professional experience and credentials to ascertain and certify their fitness for their jobs."
>
> "The Flight Safety Office should be fitted in a position where it may override the other departments in the organisation structure"

### 5.1.3 Discussion of the role and position of airline safety staff

Two more frequently asked questions about airline safety management in the organisational structure are 1) where the flight safety department should be installed and 2) to whom the safety manager should report.

The oral and written comments gained from interview and questionnaire surveys revealed that the line pilots felt the necessity to place the flight safety department at a higher level, so that the safety manager could have more influence or power to deal with the unsafe practices they reported. However, only two of the six airlines surveyed did so. As shown in Tables 5.2 and 5.3, a high percentage of the pilots, especially those military-trained First Officerss in regional airlines, gave negative answers about the influence of safety staff and their position. It is no wonder that 79% of the interviewees said that they would rather report a safety concern to someone other than the flight safety staff.

*Autonomy of safety department* The organisational position of the safety department affects the amount of power possessed and the effectiveness of safety. Unless the safety manager can report directly to a boss with influence and who wants safety, he will not have the authority to create a safety environment. Besides, whom the safety manager reports to is critical because it shows the airline's commitment to safety that the airline gives, and it affects the willingness of the line pilots to report operational anomalies that could compromise safety. When the safety department comes under flight operations, the ineffective position is likely to cause the hesitation of pilots in reporting unsafe practices because their suggestions will be reviewed by the same individual who is their day-to-day boss. The safety department should be an autonomous unit; it should not come under the flight operations or maintenance departments. In any case, the safety manager must hold a position of such stature that all channels in the organisation are open to him.

*The role of the safety manager or officer* The safety manager has to bridge the gap between top management and line employees, and to maintain a close working relationships throughout the organisation. He should be responsible to the top management by enabling the line to exercise the authority effectively on behalf of safety, and he should be approachable by the pilots so that they can communicate their own weaknesses, errors and perception of hazards without fear of reprisals. He should also provide feedback through an internal newsletter with contributions from company personnel and articles from other publications that may be relevant to aviation safety. He should make safety everybody's business rather than the responsibility of the safety department alone.

## 5.2 Corporate and cockpit culture

### 5.2.1 Introduction

As described in Chapter 3, section 3.4, culture is a reflection of deeply held beliefs and values, which affect our attitudes, our behaviours and our interactions with others. In aviation, differences in pilots' attitudes can stem from differences in cultural backgrounds. Therefore, safety management in multi-cultural airlines especially need to be aware of and appreciate the role of cultural differences and similarities in the flight operations.

The second section first presents the responses of the pilots on the following five statements about the corporate culture.

1. The awareness of safety in the company is good.
2. Channels for communication are accessible.
3. Flight and ground crews co-ordinate well.
4. Company's policy encourages voluntary safety reports.
5. Crews are willing to report hazards / incidents.

More discussion is then provided to look closer into their opinions of cockpit culture in terms of military background influences and flying with expatriate pilots.

### 5.2.2 Pilots' responses to corporate and cockpit culture

#### 5.2.2.1 Corporate culture

Figure 5.2 illustrates the overall opinions of the pilots surveyed about corporate culture. In response to the first statement "The awareness of safety in the company is good", the majority of the respondents in the postal survey (70.4%) gave positive responses and only 29.1% gave negative responses. With regard to channels for communication, a significant percentage (67%) of the respondents did not think they were accessible. Approximately 50% of the flight crews surveyed disagreed that flight and ground crews co-ordinated well. More than half of the respondents (57.5%)

agreed that the policy of their companies encouraged voluntary safety reports, but 51.8% of the them did not agree that crews were willing to report hazards / incidents.

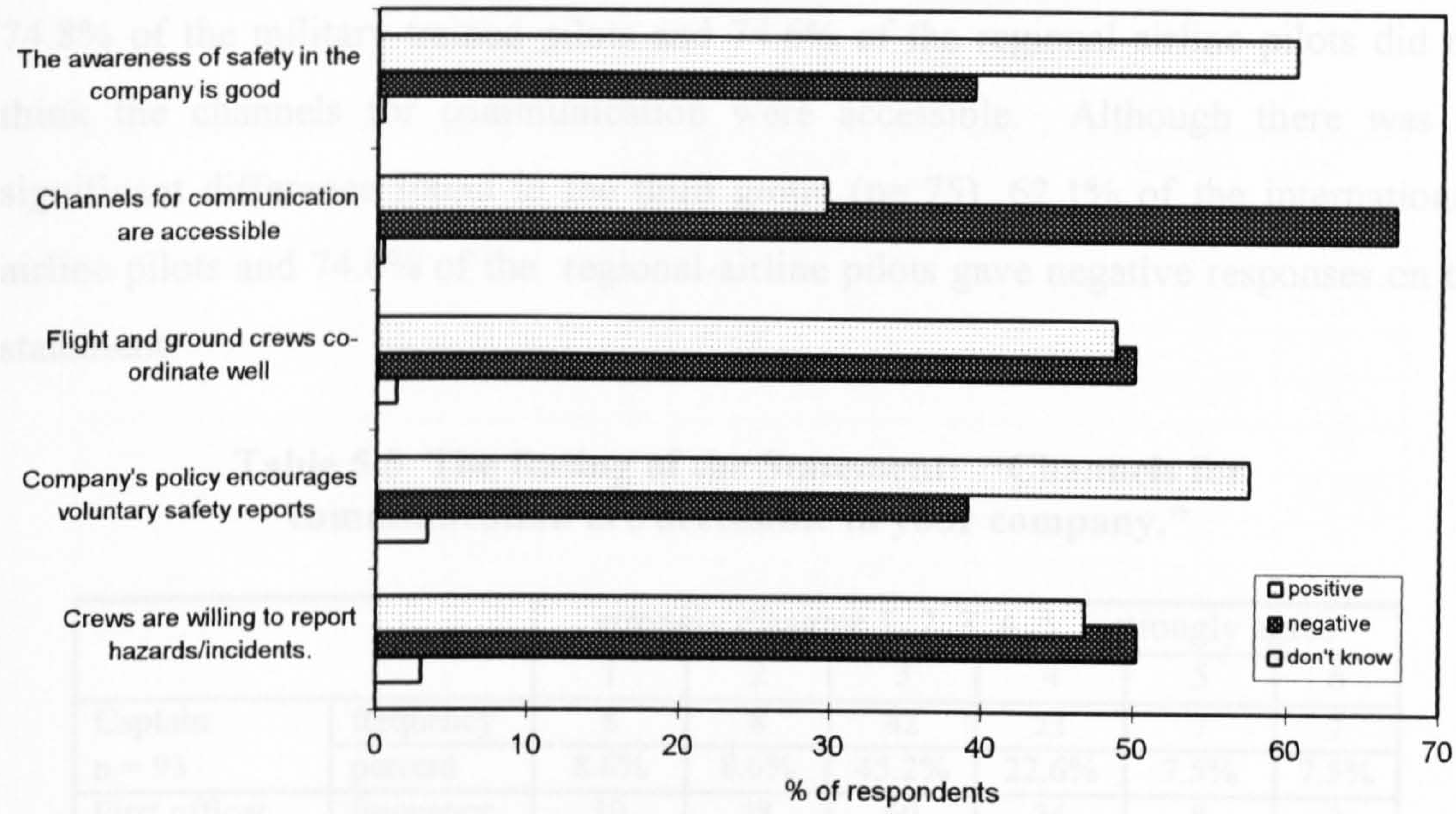



**Figure 5.2 Pilot's Responses to Corporate Culture**

*Channels for communication* As shown in Table 5.5, there were significant differences between Captains and First Officerss at the .05 level, and between military- and *Ab-initio* trained pilots at the .01 level. 74.3% of the First Officerss, 74.8% of the military-trained pilots and 74.6% of the regional-airline pilots did not think the channels for communication were accessible. Although there was no significant difference found in the third group (p=.75), 62.1% of the international-airline pilots and 74.6% of the regional-airline pilots gave negative responses on the statement.

**Table 5.5 The Rating of the Statement: "Channels for communication are accessible in your company."**

| | | strongly disagree 1 2 3 4 5 6 strongly agree | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Captain | frequency | 8 | 8 | 42 | 21 | 7 | 7 |
| n = 93 | percent | 8.6% | 8.6% | 45.2% | 22.6% | 7.5% | 7.5% |
| First officer | frequency | 10 | 28 | 60 | 24 | 8 | 2 |
| n = 132 | percent | 7.6% | 21.2% | 45.5% | 18.2% | 6.1% | 1.5% |
| Military | frequency | 16 | 29 | 89 | 28 | 9 | 8 |
| n = 179 | percent | 8.9% | 16.2% | 49.7% | 15.6% | 5.0% | 4.5% |
| *Ab-initio* | frequency | 2 | 7 | 13 | 17 | 6 | 1 |
| n = 46 | percent | 4.3% | 15.2% | 28.3% | 37.0% | 13.0% | 2.2% |
| International | frequency | 4 | 14 | 41 | 20 | 11 | 5 |
| n = 95 | percent | 4.2% | 14.7% | 43.2% | 21.1% | 11.6% | 5.3% |
| Regional | frequency | 14 | 22 | 61 | 25 | 4 | 4 |
| n = 130 | percent | 10.8% | 16.9% | 46.9% | 19.2% | 3.1% | 3.1% |

[$x^2_{obt}$ = 11.13, df = 5, p<.05] Captain vs First Officer
[$x^2_{obt}$ = 13.6, df = 3, p<.01] Military vs *Ab-initio*
[$x^2_{obt}$ = 9.98, df = 5, p= .075] International vs Regional

*Co-ordination of flight and ground crews* In response to crew co-ordination, Chi-square analysis revealed that there was significant difference between military- and *Ab-initio* trained pilots. 57% of the military-trained pilots disagreed that flight and ground crews co-ordinated well in their airlines, whereas only 21.7% of the *Ab-initio* trained pilots indicated their disagreement. There were no significant differences between Captains and First Officerss, and between international- and regional-airline pilots, but more First Officerss (52.8%) and regional-airline pilots (50.8%) were against the statement. There was a tendency that the First Officerss with military background were inclined to show disagreement on the statement about crew co-ordination.

**Table 5.6 The Rating of the Statement: "Flight and ground crews co-ordinate well in your company."**

| | | strongly disagree 1 2 3 4 5 6 strongly agree | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Captain | frequency | 0 | 2 | 40 | 24 | 17 | 9 |
| n = 92 | percent | 0% | 2.2% | 43.5% | 26.1% | 18.5% | 9.8% |
| First officer | frequency | 1 | 18 | 54 | 32 | 26 | 7 |
| n = 138 | percent | 0.7% | 13.0% | 39.1% | 23.2% | 18.8% | 5.1% |
| Military | frequency | 1 | 17 | 87 | 38 | 26 | 15 |
| n = 184 | percent | 0.5% | 9.2% | 47.3% | 20.7% | 14.1% | 8.2% |
| *Ab-initio* | frequency | 0 | 3 | 7 | 18 | 17 | 1 |
| n = 46 | percent | 0% | 6.5% | 15.2% | 39.1% | 37.0% | 2.2% |
| International | frequency | 1 | 8 | 39 | 23 | 24 | 3 |
| n = 98 | percent | 1.0% | 8.2% | 39.8% | 23.5% | 24.5% | 3.1% |
| Regional | frequency | 0 | 12 | 55 | 33 | 19 | 13 |
| n = 132 | percent | 0% | 9.1% | 41.7% | 25.0% | 14.4% | 9.8% |

[$x^2_{obt}$ = 8.97, df = 3, p<.05] Military vs *Ab-initio*

*The willingness to report hazards / incidents* There were wide variations among the three comparison groups. Approximately two thirds of the First Officerss (62.6%) and *Ab-initio* trained pilots (66%) disagreed that crews were willing to report hazards / incidents, while 35.8% of the Captains and 48.1% of the military-trained pilots thought so. Chi-square was statistically significant at the .05 level for both ranking and initial training groups. Once again there was considerable difference in the airline comparison group (p<.01). 71.8% of the international-airline pilots indicated their disagreement, but merely 37% of the regional-airline pilots disagreed that crews were willing to report hazards / incidents.

**Table 5.7 The Rating of the Statement: "Crews are willing to report hazards/incidents."**

| | | strongly disagree 1 2 3 4 5 6 strongly agree | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Captain | frequency | 1 | 12 | 20 | 32 | 19 | 8 |
| n = 92 | percent | 1.1% | 13.0% | 21.7% | 34.8% | 20.7% | 8.7% |
| First officer | frequency | 1 | 24 | 59 | 29 | 11 | 10 |
| n = 134 | percent | 0.7% | 17.9% | 44.0% | 21.6% | 8.2% | 7.5% |
| Military | frequency | 1 | 26 | 59 | 52 | 26 | 15 |
| n = 179 | percent | 0.6% | 14.5% | 33.0% | 29.0% | 14.5% | 8.4% |
| *Ab-initio* | frequency | 1 | 10 | 20 | 9 | 4 | 3 |
| n = 47 | percent | 2.1% | 21.3% | 42.6% | 19.1% | 8.5% | 6.4% |
| International | frequency | 1 | 19 | 49 | 16 | 8 | 3 |
| n = 96 | percent | 1.0% | 19.8% | 51.0% | 16.7% | 8.3% | 3.1% |
| Regional | frequency | 1 | 17 | 30 | 45 | 22 | 15 |
| n = 130 | percent | 0.8% | 13.1% | 23.1% | 34.6% | 16.9% | 11.5% |

[$x^2_{obt}$ = 8.25, df = 5, p<.05] Captain vs First Officer

[$x^2_{obt}$ = 7.87, df = 3, p<.05] Military vs *Ab-initio*

[$x^2_{obt}$ = 18.48, df = 5, p<.01] International vs Regional

### 5.2.2.2 Culture in the cockpit

*Military background influences* As noted in Chapter 3, in high power distance countries, pilots transitioned from military flying tend to be aggressively result-oriented. Such military background influences are likely to emerge if insufficient training is in place to neutralise that attitude when pilots enter civil-air-transport operations.

In this study, all of the *Ab-initio* trained pilots were trained overseas after being recruited. They comprise 19% of the sample (*Ab-initio* trained pilots consists of 17.8% of the study population). The rest of the pilots were retired military pilots, who received their initial flying training in the military. When asked what special communication experience in the cockpit they had, many interviewees mentioned the conflict resulting from differences in background culture.

Below are some transcripts of the interviews about the deviation of safety recognition between military-trained Captains and *Ab-initio* trained First Officerss:

> *"After the aircraft was pulled back, the captain asked me to do *** test. I instinctively told him that the test should have been done before take-off. He replied, 'Just do what I tell you...' I hesitated a while but obeyed his command because I figured out that I still had three continuous flights with him on that day."*
>
> *"I am accustomed and convinced that reading the procedure checklist to operate accordingly is accurate. But one day, a captain said, 'Having flown for six months, how come you do not memorise the approach chart!' I dared not reply and did not know what to do."*

The difference of safety recognition not only results in the differentiation of operation but also causes other problems. For example, subordinate pilots dared not question or correct their Captains lest something adverse might happen. Some more transcripts exemplify the phenomenon of hierarchical relationships.

> *"Because there were not so many passengers on board, the captain asked the flight attendants to save the passenger safety briefing. I thought it was wrong but did not know how to manage."*
>
> *"For their convenience of getting on and off the aircraft, our flight attendants always arrange senior passengers and children to sit beside the cabin doors. From the viewpoint of safety, they will obstruct cabin evacuation during an emergency...I don't know what to say as the captain feels it is all right."*
>
> *"It was about 7:00 in the evening when the aircraft approached X airport. It was pouring with poor visibility, and the captain was flying the aircraft. I thought it was time to turn to final when it approached the mountains, but the captain did not make any move. I reminded him politely, 'Sir, it is about time to turn.' He did not respond and I said again, 'Sir, it is time to turn.' There was still no reaction.... I hesitated a while, and said for the third time, 'Sir, we must turn to final right now.' At the same time, I operated the aircraft to final. (I thought the captain was out of his mind.) Soon after that, I heard the warning sound of GPWS 'too low, too low'....After landing, I was still worried that my override would cause a consequently bad influence with the captain."*
>
> *"I have to learn how to ask the right questions, the questions that the captain knows how to answer. If I ask a question that the captain does not understand, it will be viewed as arbitrary query. That making the captain feel he is losing face is likely to worsen the cockpit atmosphere."*

It is obvious that when the cultures are in conflict, crews become unsure of how to proceed or behave. Uncertainty, hesitation and frustration follow. Safety is, consequently, compromised. An interviewee commented that safety compromise was more a problem of the organisational culture than the conflict of background culture. He illustrated the point very clearly: "....regulation and law protection are useless. You can do nothing if culture doesn't change, for most colleagues will boycott you."

*Flying with expatriate pilots* In five of six subject airlines, expatriate pilots are employed from around the world to "fill the pilot-shortage and experience gap" until enough local pilots are fully qualified to staff the company. Most expatriate Captains in the target population are retired from other airlines and have much flying experience. However, because they are employed on the basis of a short-term contract, they are usually hard to gain complete acceptance and the perception of such secondary status is apt to foster low commitment.

Based on the interviews and comments on the questionnaire, some pertinent points about the experiences of working with expatriate pilots are made below.

*Advantages* The most quoted advantage of flying with expatriate pilots is less pressure. Several interviewees, and particularly First Officerss, also emphasised that working under such a non-threatening environment fostered better performance.

> "Less pressure is felt when I work with expatriate pilots."--------*Less Pressure*

> "The majority of native pilots will treat us like the second auto pilot and treat us like trained pilots. I will be more aggressive when flying with multinational crews, but definitely not with our own national crews."---------*Less Pressure*

> "Though language barrier exists, expatriate pilots are easier to communicate with. On the contrary, native pilots are more stubborn and have stronger hierarchical concept."--------*Less Pressure*

> "It is more relaxing to work with them, and I fly better."--------*Less Pressure & Better Performance*

> "My performance will be better to fly with multinational crew because I will feel more free to question captain's decisions and give more advice."--------*Better Performance*

Additionally, expatriate pilots were praised for their valued co-operation, adherence to SOP precisely, and the willingness to share their experience.

> "Native pilots tend to be more authoritative and harder to communicate with. Native pilots value cockpit ethics, but expatriate pilots value co-operation."--------*Less Pressure & Co-operation*

> "Expatriate pilots divide PF and PNF clearly, so when working with them, First Officerss can focus on PF and do their best."--------*Co-operation*

> "The cockpit atmosphere is more open and comfortable when flying with a foreign captain. You can make your decision freely and discuss with the captain reasonably. The native captain will use what he calls experience by himself to disregard all decisions you make. Sometimes, you wonder what he knows about aviation except flying the aircraft."--------*Less Pressure & Co-operation*

> "Expatriate pilots value First Officerss' responsibilities. They respect our viewpoints. Thus, our performance improves and confidence is consequently built up."---------*Co-operation & Better Performance*

> "Expatriate pilots explain clearly during takeoff and landing. They value crew co-operation to complete each mission."--------*Co-operation*

> "They fully follow the SOP and FCOM. If they have a different view, they will raise up the question and seek for advice and discussion."---------*SOP & Co-operation*

> "Expatriate pilots are more willing to share their knowledge and experience with other crew members."--------*Experience Sharing*

*Disadvantages* In addition to the advantages described above, the surveyed pilots also mentioned the disadvantages of working with expatriate pilots. They are frustrations mainly stemming from the difference of language and culture.

The main disadvantages cited by twenty-two of the interviewees was with the language. Language barriers caused difficulties in communication and co-operation and influenced the transmission and sharing of safety information. 42% of the pilots agreed they suffered a language gap on receiving safety-related information (Further discussion about language barriers will be provided in Section 5.7). Some clues come from the interviews and the written comments.

"During long haul flight, it often seems that no topics of conversation are found except talking about flying the airplane. Long haul flight is boring."--------*Language Barrier*

"Because I am not able to express opinions freely in English, language communication is limited to flying, and there is no chance to get to know each other more. The language barrier seems to distance us."--------*Language Barrier*

"The English accent of those who come from non-English speaking countries is not easily understood."--------*Language Barrier*

"Expatriate pilots speak too fast to understand, especially at the first contact."--------*Language Barrier*

"Due to language barrier, it is difficult to get along well with them. Not always understanding fully."--------*Language Barrier*

"It takes time to understand their operations and attitudes. It is necessary to use different expressions to avoid misunderstanding."--------*Language Barrier*

"Failure to recognise deterioration flight, weather or system problems which will cause bigger problems or a later emergency situation."--------*Communication in Emergency*

"I have a much higher sense of awareness of all switch positions, aircraft configuration and clearances to prevent problems due to misunderstanding."--------*Communication in Emergency*

In addition to language problems, the difference in background and life style was also addressed. The cultural difference caused incomprehension or even misunderstanding between the local and the expatriate pilots, and sometimes caused expatriate pilots a feeling of detachment from the airline they were working for.

Here are some quotations about incomprehension and misunderstanding.

"Misunderstandings happen due to different culture."--------*Misunderstanding*

"It is not about the problem of language. It is about the way they talk, which is very different from what natives are used to."--------*Incomprehension*

"Due to different background, it takes time to communicate. I do not understand their jokes."--------*Incomprehension: Different Senses of Humour*

The frustrations with expatriate pilots also included racial discrimination.

> "Racial discrimination and cultural gaps between east and west mostly come from 'X' crews. Generally, 'XX' crews are more understanding and easier to work with."--------*Racial Discrimination*

> "Some expatriate pilots have inexplicable sense of superiority: they rebuke other aircrews due to language problems."--------*Racial Discrimination*

The most cited reason for detachment occurring was that the expatriate pilots still followed their previous company's policy on operation and ignored the regulations of the current company (*Customs Conflict*). The detachment also reflected on their behaving like an outsider (*Low Involvement*). Some mentioned that they did not know how to get along with them (*Social Separation*).

> "Expatriate pilots still follow the previous company's policy on operation. Some expatriate pilots do not know the company's regulations."--------*Customs Conflict*

> "It looks like they are doing summer jobs rather than their careers. He kept on asking me whether I would like to share coffee with him."--------*Customs Conflict*

> "They have crew concept, but no company concept."--------*Customs Conflict*

> "Expatriate pilots care less about the company's policy, and that easily causes misunderstanding. Besides, they seldom participate in group activities."--------*Customs Conflict & Low Involvement*

> "It is difficult to understand their personalities due to language and culture problems."--------*Social Separation*

Some other arguments were listed below:

> "Expatriate pilots like to fly manually, which adds to the workload."---------*More Workload*

> "You receive a diverse view of ideas and operational procedures based on different backgrounds."--------*Uncertainty*

> "A few misbehaving pilots like to put the blame on bad communication to cover up their own misconduct."--------*Misleading*

### 5.2.3 Discussion

From the survey, more than half of the respondents indicated that the awareness of safety was good and voluntary safety reports were encouraged in their airlines. Nevertheless, the majority of them also showed their disagreement on accessible communication channels, crew co-operation and willingness to report hazards or incidents. All the indications reflect that there was a gap between the desired state (perception) and the actual state (implementation).

*From passive to active safety management* The analysis of the survey data discussed above suggested that top management in the airlines did recognise the need to enhance safety, but effective safety management requires more than simply knowing about the importance of safety or paying lip service to the regulations. Actual managerial practices needed to be improved in order to reduce the impact of discordant culture on safety. Unfortunately, there is no simple or universal solution for cultural conflicts and confusion. The ways to minimise cultural problems vary, depending on the particular characteristics of each culture. To strengthen organisation's ability to deal with these issues, cultural conflicts need to, therefore, be diagnosed and understood. Then, desired norms could be reinforced and leadership should be provided to unify the diversities in sub-cultures.

From the foregoing discussion of the problems caused by cultural and language differences in the study, four recommendations were suggested: 1) requesting all the crew to take CRM course, 2) offering language skills training, 3) providing cultural awareness training and 4) creating group-identity activities.

*CRM training* Military mentality and cultural frustrations such as those described above hindered effective crew co-ordination and communication. The purpose of CRM training programmes focuses mainly on improving the attitudes, behaviour and performance of newly qualified and experienced pilots, so that each individual understands his or her personal role as a leader or follower in the team and recognises the need for good communication and co-ordination. To ensure the success of the programme, CRM training should not only provide basic human performance and limitation concepts but need to define clearly operational norms and rules for individual pilots to abide by.

*Language training* Language barriers as described above tend to produce difficulties in communication and co-operation, which can have serious implications for safety. Language training aimed at overcoming language barriers should include both the non-native English pilots and native English pilots flying with non-native English crews as well. To non-native English pilots, mastery of aviation English should be one of the most important requirements, though safety management seldom places emphasis on it. To native English pilots, though they have the linguistic advantage because English is the formal language of international commercial aviation, they need to be trained to be aware of and more sensitive to the difficulty of communicating in other than one's first language. The use of plain English should be emphasised to ensure understanding.

*Cultural awareness training* Each culture has its own relative strengths and weaknesses. Perceiving the differences in underlying cultural values helps to promote better understanding of the behaviours of individual pilots. Besides, an analysis of corporate and cockpit cultures and the influences affecting them might be beneficial for generating improvements in safety. Moreover, cultural awareness can be integrated into existing training packages without large financial outlay(Merritt, 1995).

In high power-distance cultures of the study, communication was influenced by these hierarchical relationships. The high power and social distance between captain and crew made a junior pilot reluctant to advise a senior pilot of an observed mistake, or question his decisions. Accordingly, safety management needs to adopt the correct attitude in minimising conflict and uncertainty, reinforcing the desired norms, and providing leadership which unifies the diverse subcultures.

*Group-identity activities* As noted earlier, the expatriate pilots were employed as "guest workers" on the basis of short-term contract, so it was difficult to establish a team spirit or group identity. Creating the opportunity for a multi-national crew to attend local crew's activities is necessary to reduce the social separation and encourage involvement.

## 5.3 The involvement of management in safety

### 5.3.1 Introduction

The third section addresses the relationships of management to aviation safety. Management attitudes and behaviour have a profound effect on safety practice (Grimaldi and Simonds, 1984; Petersen, 1988; Jensen, 1995): They affect pilot judgement on managing risks and flight operations. As noted in Chapter 3, it was not until recently that responsibility for human error has been placed airline management as well as pilots. This systematic thinking approach looks for a chain of factors and often reaches far outside the cockpit.

As management's commitment to safe operations may influence safety performance in an airline, the four statements in this section were to elicit pilots' responses to the involvement of management on safety in their airlines. They are as follows:

1. Top management is dedicated to supporting safety policies / events.
2. The company's response to changes in policies and procedures after the occurrence of incidents / accidents is good.
3. Operations mangers are strongly involved in the safety events.
4. The reward system for safety is well organised.

Comments made by the pilots interviewed were analysed to determine their expectations for reward methods and their perceptions about use of a punishment base approach.

### 5.3.2 Pilots' responses to the involvement of management in safety

Figure 5.3 illustrates the overall opinion of the pilots on the four statements. In response to the first statement, more than 40% of the pilots disagreed that top management was dedicated to supporting safety policies / events. Though the majority of pilots showed their agreement on the second and the third statements, more than 20% of the respondents did not agree that the company's response to changes in policies and procedures after the occurrence of accidents / incidents was good, and that operations managers were strongly involved in the safety events. With regard to a reward system, slightly over one-half of the respondents gave negative responses on the statement provided. Detailed analysis found that there were no significant differences between the three comparison groups.

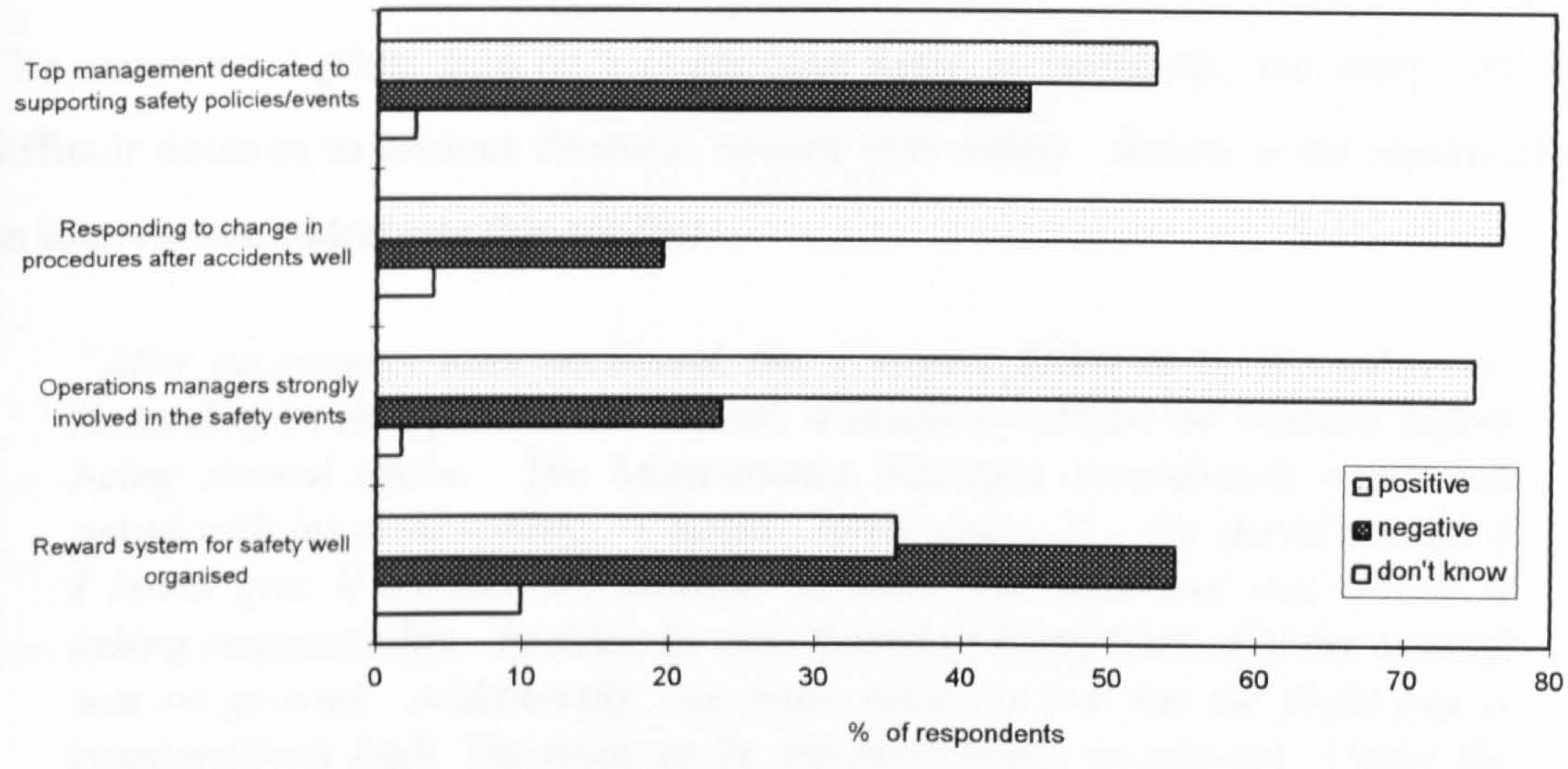



**Figure 5.3 Pilots' Responses to the Involvement of Management on Safety**

### 5.3.3 Discussion

Many airlines advertise that safety is their primary goal. This is only true if the investment in safety can prevent loss due to damage or injury and serve to promote the public image and profits of the company. The opposing goals of simultaneously maximising both safety and profits can, and often does, lead to the introduction of hazards. Therefore, the support and commitment of management, and particularly top management, are vitally important to the success of a safety programme.

*Top management influence* From the viewpoint of organisational context, the influence of top management on safety can clearly be depicted "Every accident, no matter how minor, is a failure of management.(Andrews, 1953; Lauber, 1994) " That the way management is seen to practise safety standards and sets the model for the pilots, which influences the latter's attitude toward safety. A manager concerned with productivity goals may perceive a safety programme as being a waste of efficiency and being concerned with costs, while a people-oriented manager probably will perceive safety programme as the welfare of the people. Top management, depending on their production versus people orientation, will influence and motivate line management into different actions. Their concern will, in consequence, be transmitted to line pilots and influence their judgements when operating the aircraft.

The commercial pilots paid on a flying-hour basis, in particular, are faced with the difficult decision to balance financial reward with safety. Below is the transcript of an interviewee addressing this conflict.

> *"After passengers were on board, No. 1 engine failed to be started twice. According to the operational manual, it needs to rest for 60 minutes before being started again. The Maintenance Manager immediately came and asked with his arms rolling, "Captain, could you ....?" He dared not ask if I could give it another try because he knew the rules and was afraid of taking responsibility. Besides, he also feared of being blamed if the aircraft was on ground. Additionally, our basic salary is low but the flight pay is comparatively high. The more we fly, the more bonus we can get. Under the circumstances, it is hard to make a decision............ "*

The pressure imposed on the maintenance manager by corporate goals and profit seeking leads him to tempt the pilot in lowering his margins of safety. Jensen (1995) puts it well, "understanding management's point of view is not too difficult, but usually when it comes to piloting an unsafe aircraft or making a trip in unsafe conditions, usually the management person is on the ground." Managers usually assume that pilots will give up flying if there is any 'real' danger, and do not take into consideration the fact that pilots could face a life or death situation in order to comply with strong pressures and attempting to keep their jobs. It is not only a matter of indifference to the pilots' predicament but also a problem over the allocation of safety responsibilities. Though management influences the attitudes and actions of line pilots, safety responsibilities have been allocated exclusively to the front-line operators since they are the ones that make the unsafe decisions and the managers have little or direct control over them.

Top management has great opportunities to contribute to safety within an airline. It defines the safety culture and decides where safety can help to meet the productivity objectives. If top management does not define clearly what can be done to achieve company goals within safety constraints, it is likely, as in the above case, that the flight crews, and even the middle management, may not know how to react in situations when safety and profits are in conflict. Clear accountability for safety at all levels helps to reduce risk and enhance safety. Active involvement also demonstrates the management's commitment to safe operations.

*Reward system and punishment approach* In addition to top-down support, a bottom-up approach is useful to represents help ensure safety. Punishment and reward are analogous to a coin with two faces. The former is a passive way to diminish undesired actions or conditions; the latter actively induces desirable outcomes.

In safety, utilising a "punishment" approach should be carefully examined. Premature focus on blaming the pilot for what may in fact be due to factors totally beyond his control can delude management into ignoring causal factors, rather than remedying them. Thus, pilot punishment for accidents may, in the absence of identifying all relevant causal factors, mask other subtle and residual factors that may escape appropriate attention. Some interviewees were worried that the long-term use of severe punishment might result in the following side effects.

> *"Captains are not willing to allow First Officers to operate the aircraft."*
>
> *"Pilots tend to overuse automatic flight system in order not to deviate from required standard and be punished."*
>
> *"Captains are afraid of filing a report to suggest what First Officers need strengthening."*

Other interviewees mentioned how a punishment approach backfired as well as their reactions to the approach.

> *"Flight and ground crews do not co-operate well enough. When problems come up, they either cover them up or lay the blame on each other."*

> *"There should not be any disciplinary action taken on refusing to fly aircraft for safety reasons."*

A reward system, conversely, reinforces continued safety effort. Rewards can either be formal or informal. Formal systems include a promotion, a merit salary increase, letters of accomplishment or appreciation, formal performance appraisals, etc. Informal ones are the daily "thank you's" or "pats on the back," or the informal communication network of the organisation. The value of reward depends on how attractive the potential outcome is to individuals. For example, a promotion might have very little positive value, because of a lack of desire to take on increased responsibilities. Therefore, it is important to identify the perceptions of employees about what individuals are rewarded for, and for what they will be reprimanded or punished. The opinions derived serve to influence efforts made in the future.

From the results of the survey, it is obvious that the subjects in the study were not satisfied with the reward system in their airlines. The usual comments mentioned were as follows:

> *"The company usually rewards individuals but punishes the whole team."*
>
> *"The company has punishment regulations? but does not have reward rules."*
>
> *"Rewards are offered to Captains but not to First Officers."*
>
> *"Rewards are offered too slowly to have good effect. Internal circulars do not fulfil their function."*

The unfairness in the reward and punishment systems was clearly expressed by an interviewee, who highlighted his dissatisfaction by saying that *"Our company gives small reward and severe punishment."*

A punitive approach is not constructive. Most errors are good honest mistakes (not deliberate or wilful neglect) which are made by people simply trying to get the job done. These errors are indicators of the system deficiency or failure and should not be utilised to assess individual performance. Apart from the abatement of punishments, rewards should enhance teamwork rather than individual performance. In order to build up the concept of teamwork, they should be offered to the whole team, rather than to individuals, and should be offered immediately in doer to ensure their effectiveness.

## 5.4 Flight training

### 5.4.1 Introduction

Rapid growth of airline structures and fleets cause a great demand for more pilots in the subject country. As a result, airlines have had to train their own pilots or recruit pilots from military, and quickly promote them to fly the complex aircraft currently in service. Under these circumstances, pilots tend to have relatively low levels of training and experience. In order to fly safety and efficiently, the provision of sufficient training has become more important than ever.

In addition, increasing levels of aircraft automation have changed the way in which aircraft are operated, and consequently, training needs have altered considerably. Safe and successful operation of commercial aircraft requires more than the traditional "stick-and-rudder" skills. Accordingly, a pilot is no longer an active operator but a system manager, and aircraft are flown not by individuals but by crews (Orlady, 1993). In today's environment, both traditional training and human factors training are required to prepare pilots, both on using basically technical skills and on dealing with the human-machine relationship (Wiener et al, 1991).

The issues and concerns inherent in flight training are discussed in this section with focus on the aspects of outsourcing training and human factors training.

### 5.4.2 Pilots' responses to airline flight training

Figure 5.4 shows the comparison of the positive and negative responses regarding flight training and operations. It is obvious that more respondents gave positive responses to the quality of recurrent training, the working experience of qualified crew members, selection criteria for flight crews, and standardisation of checklists and manuals. However, a high percentage of negative responses were revealed about recurrent training (31.7%), working experience of qualified crew members (27.1%), and selection criteria (38.6%). With regard to the effectiveness of human factors training, over 50% of the pilots indicated their disagreement.

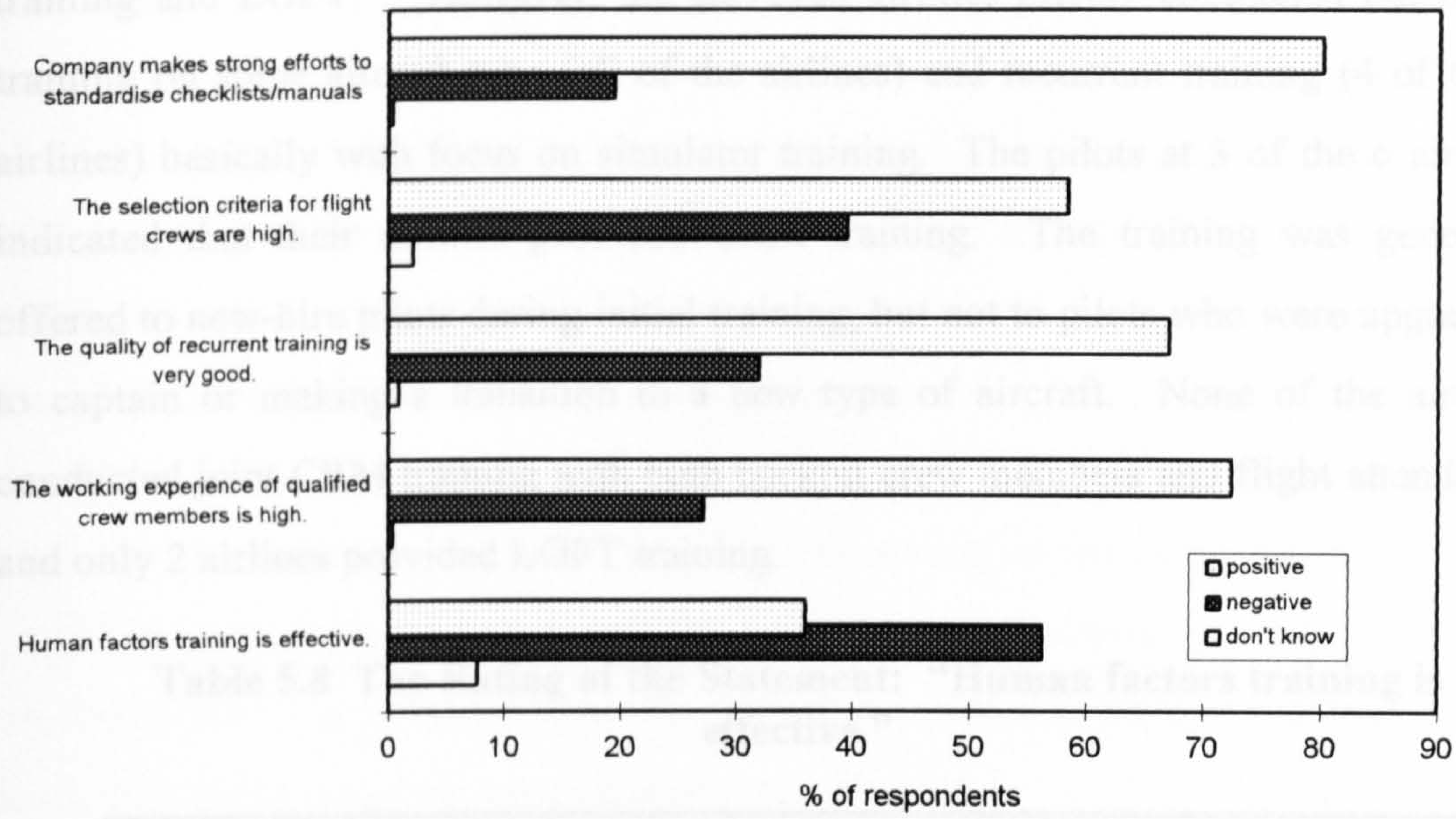



**Figure 5.4 Pilots' Responses to Flight Training**

Detailed analysis based on sub-groups shows that there was significant difference at the 0.01 level between Captains and First Officers (see Table 5.8). What needs to be cautioned is that one fifth of the Captains surveyed strongly disagreed that human factors training in their airlines was effective. There were no significant differences found in the other two comparison groups. With the exception of *Ab-initio* trained pilots (38.3%), more than half of the other pilots gave negative responses to the statement, which corresponded to 61.3% of the military-trained pilots, 52.6% and 59.1% of the pilots working respectively for international and regional airlines.

Further information on flight training was obtained during the interviews. Of the 34 pilots who were asked, 30 (88.2%) indicated that professional references were requested, but only 4 (11.8%) of them reported that the information on the types of preemployment background was verified. All of the pilots reported that their airlines imposed minimum standards for new-hire pilot qualifications and captain upgrade qualifications. When asked about contract flight training, all of the subject airlines contracted out their entire pilot training program to contract training centres. In general, these centres provide a complete service, including the screening and selection of pilot candidates; initial ground school and flight training of newly hired pilots; aircraft transition, captain upgrade, recurrent training and check flights; CRM training and LOFT[24]. However, the surveyed airlines merely contracted out initial training on some aircraft type (all of the airlines) and recurrent training (4 of the 6 airlines) basically with focus on simulator training. The pilots at 3 of the 6 airlines indicated that their airlines provided CRM training. The training was generally offered to new-hire pilots during initial training, but not to pilots who were upgrading to captain or making a transition to a new type of aircraft. None of the airlines conducted joint CRM training with both cockpit crew members and flight attendants, and only 2 airlines provided LOFT training.

**Table 5.8 The Rating of the Statement: "Human factors training is effective."**

| | | strongly disagree 1 2 3 4 5 6 strongly agree | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Captain | frequency | 17 | 8 | 21 | 21 | 11 | 7 |
| n = 85 | percent | 20.0% | 9.4% | 24.7% | 24.7% | 12.9% | 8.2% |
| First Officer | frequency | 2 | 22 | 51 | 30 | 16 | 9 |
| n = 130 | percent | 1.5% | 16.9% | 39.2% | 23.1% | 12.3% | 6.9% |
| Military | frequency | 15 | 24 | 64 | 36 | 18 | 11 |
| n = 168 | percent | 8.9% | 14.3% | 38.1% | 21.4% | 10.7% | 6.5% |
| Ab-initio | frequency | 4 | 6 | 8 | 15 | 9 | 5 |
| n = 47 | percent | 8.5% | 12.8% | 17.0% | 31.9% | 19.1% | 10.6% |
| International | frequency | 9 | 12 | 29 | 23 | 14 | 8 |
| n = 95 | percent | 9.5% | 12.6% | 30.5% | 24.2% | 14.7% | 8.4% |
| Regional | frequency | 10 | 18 | 43 | 28 | 13 | 8 |
| n = 120 | percent | 8.3% | 15.0% | 35.8% | 23.3% | 10.8% | 6.7% |

[$\chi^2_{obt} = 25.33$, df = 5, $p<.01$] Captain vs First Officer

### 5.4.3 Discussion

*Outsourcing training* In general, benefits attributed to contracted training are access to flight simulators and more experienced instructors, uniformity of instruction, and a reduction in workload for senior management and pilots. Among

[24] LOFT (Line Oriented Flight Training) provides a method of exposing a crew in a full mission simulator to complete flight operations (such as pre-flight operations, the flight itself and the post-flight activity) in such a way that company procedures, flight procedures, flying techniques and cockpit management (human factors) are observed without providing any more assistance to the crew than it would have on a real flight. Crew operation and teamwork shortcomings are reviewed during debriefing by a training pilot. Some airlines have introduced video recording and playback into the debriefing and found this beneficial in allowing self-critique by the pilots. Thorough preparation of LOFT scenarios is essential in order to provide a maximum of crew decisions, actions and opportunity for error in a realistic flight that imposes an abundance of high crew workload and stress.

the many training approaches available, simulator training allows hazardous manoeuvres to be practised in a safe environment. In particular, the majority of airlines usually conduct pilot training at night, so pilot and instructor tend to be tired. For example, on the 11th of September 1979, 6 flight crew of China Airline Boeing 747 were killed whilst training in a company aircraft at night outside Taoyuan, Taiwan. In addition to safety considerations, the cost of training in a simulator is usually less than the cost of training in an aircraft, but the expense of sophisticated, high-fidelity flight simulators is likely to prevent most of the airlines surveyed from purchasing their own simulators. As aircraft manufacturers provide contracted training services as an added bonus for purchasing their aircraft, these airlines usually have their pilots trained at manufacturers training centres.

A basic problem appears to be discrepancy in the quality of training services provided. Some training centres only offer systems introductions whilst others provide complete training facilities and services. Another frequently encountered problem is that simulators used in contract training are different from the type of aircraft operated in airlines. It was also revealed in the interviews that pilots flying different series of the same basic aircraft type generally took the same aircraft system course. The inability of training centres to provide adequate instruction to cater for an airline's specific needs will be likely to affect training effectiveness. Thus, airlines must attempt to advantage of the relative strengths of contracted training and try to dispel its limitations ,in order to increase the value and effectiveness of the services obtained.

*Human factors training* In order to increase awareness and promote amore responsible attitude towards the importance of human factors in civil aviation, human factors training has become a requirement for ICAO contracting countries since 1992. In ICAO's Annex I, all pilots are required to be familiar with human performance and limitations as they relate to their flying activities and the formal privileges of their license.

The application of human factors in the aviation system takes the form of CRM. In recent years, CRM has been subject to increased attention from the airline industry, due to the growing number of accidents and near misses in air traffic. One of the prime aims of CRM is to encourage cockpit crews, in particular inexperienced First Officers, to be more assertive in reminding other crew members when they deviate from prescribed operating standards. Other operational changes include increasing the responsibility of the First Officer, and encouraging the Captain to consult with the First Officer for suggestions and opinions, in order to create an effective and open flight environment.

Based on Hofstede's measurement, the subject country is inclined to high power distances. It is understandable that the junior crews surveyed never challenged their Captain, but intend expected the Captain to give orders. Also most of the Captains did not attempt to create a communicative cockpit environment. Examples were provided by two of the First Officers interviewed about how they tried not to affront their Captains.

> *"It was Captain that was flying IFR to xxx Airport. As the aircraft (Airbus 300-600R) was making an ILS approach to runway 31, Captain inadvertently activated the GO lever, like what happened in Nagoya accident. I reminded Captain three times before he made the correction. However, I could tell he was a little upset probably because of losing face. On our flight to return to xxx, during the taxi check I set V2 (takeoff speed) to V1 (decision speed) on purpose in order to let him correct my mistake. As planned, he noticed the mistake and corrected me. Then, I said, 'Thank you. To err is human.' Captain responded with 'Yes, to err is human. People always make mistake.' How to please Captain is the spirit of CRM because when Captain is happy, you are happy."*
>
> *"Face is more important to military-trained Captains, who always think that they had flown fighters for more than 20 years without any accident, how could there be any problems to fly commercial aircraft? Thus, if they feel they lose face with their fellow crew members on this flight, they will try to win it back on next flight."*

Other interview results showed that CRM training disappointed the subject pilots because what was taught conflicted with cultural influences.

> *"When Captain agrees with your reminding, he thinks you have CRM concept. When he does not agree, he thinks you do not have disciplines."*
>
> *"CRM merely exists in the classroom but not in the cockpit. The CRM instructor in our company is the Captain who, as generally acknowledged, is the most difficult to communicate and has the least CRM concepts in the cockpit"*

Survey and interview results suggested that cultural differences should be exploited to move toward improved CRM practices on a regional basis. With continuous reinforcement, CRM training can improve line operators' teamwork and crew co-ordination concepts to achieve better crew performance. As mentioned in Chapter 3, transformation of human behaviour takes time, so the support of top management is critical in determining the effectiveness of CRM training. Helmreich and Foushee's research (1993) found that an organisation's commitment to the concepts of CRM and its importance in safety and crew effectiveness had demonstrated significant improvement in cockpit management attitudes. In addition, check pilots and instructors also play a critical role in influencing pilot attitudes about the value and usefulness of CRM training. Thus, there needs to be more emphasis on selection procedures for both flight instructors and check pilots, with considerable attention being paid to their ability to implement CRM principles. In addition to technical skills, they require special training in evaluating individuals in team performance and in an individual's ability to function as a team member.

## 5.5 Airline resource availability

### 5.5.1 Introduction

Considering the effective allocation of resources, an airline's two objectives are: pursuing the production goals of the organisation and safety (ICARUS, 1994; Reason, 1990). In the long term, these two objectives are compatible, but when resources are finite, conflicts of interest arise and priorities have to be decided. Such conflict is especially obvious in airlines just entering the market and those confronted with structural or financial problems. When finite resources are allocated to the pursuit of production goals, their allowances for safety may be diminished. Similarly, resources allocated to safety may also decrease those available for production. On facing this dilemma, these airlines may be tempted to give priority to production or short-term profits over safety concerns.

Management should, therefore, make rational decisions about how resources are allocated to achieve the production objectives of the organisation at acceptable levels of risk.

The section attempts to understand pilots' viewpoints on the following five statements about the availability of resources for safety in their airlines.

1. The company has invested a lot in safety improvement.
2. The company absorbs safety-related information from the industry well.
3. The company maintains incident/accident data very well.
4. The company enthusiastically participates in the aviation safety organisations and meetings.
5. The company provides very good quality safety-related information.

The results of the interview survey related to participation in safety conferences are also presented. At the end of the section, further discussion about resource availability and allocation is provided to look more deeply into the topic.

### 5.5.2 Pilots' perception of airline resource availability

Figure 5.5 illustrates the overall opinions of the pilots on statements related to airline resource availability. Less than 50% of the pilot respondents indicated that their companies had invested a lot in safety improvement. About the same percentage of the respondents disagreed that their company maintained incident/accident data very well. However, it was noteworthy that more than 10% of the respondents checked "I don't know" on this statement. In response to the fourth statement, it appeared that more than 30% of the respondents showed their disagreement. As to the provision of good quality safety-related information, a majority of the respondents were against it.

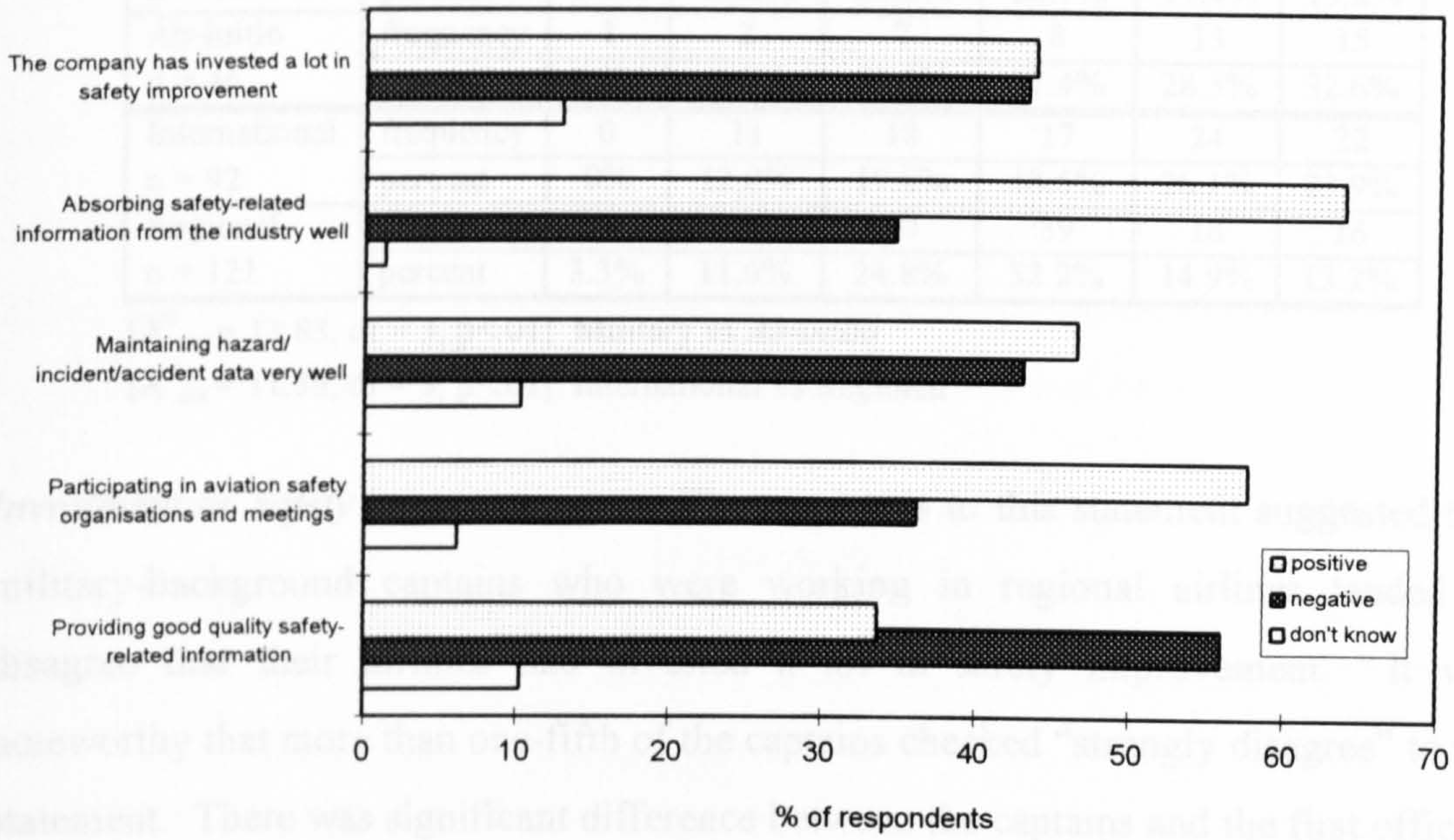



**Figure 5.5 Pilots' Perception of Airline Resource Availability**

*Participation in safety organisations and meetings* The distribution of responses based on positions, training background and airline operations are shown in Table 5.9. It appeared that a substantial number of the military-trained pilots over *Ab-initio* pilots did not believe that their company enthusiastically participated in the aviation safety organisations and meetings, with the difference significant at the .01 level. More pilots in regional airlines were against the statement than those in international airlines, with 60% indicating their disagreement. Chi-square revealed that there was significant difference at the .01 level.

**Table 5.9 The Rating of the Statement: "Your company enthusiastically participates in the aviation safety organisations and meetings."**

| | | strongly disagree 1 2 3 4 5 6 strongly agree | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Captain | frequency | 2 | 12 | 20 | 27 | 16 | 13 |
| n = 90 | percent | 2.2% | 13.3% | 22.2% | 30.0% | 17.8% | 14.4% |
| First officer | frequency | 2 | 13 | 28 | 29 | 26 | 25 |
| n = 123 | percent | 1.6% | 10.6% | 22.8% | 23.6% | 21.1% | 20.3% |
| Military | frequency | 3 | 23 | 41 | 48 | 29 | 23 |
| n = 167 | percent | 1.8% | 13.8% | 24.6% | 28.7% | 17.4% | 13.8% |
| Ab-initio | frequency | 1 | 2 | 7 | 8 | 13 | 15 |
| n = 46 | percent | 2.2% | 4.3% | 15.2% | 17.4% | 28.3% | 32.6% |
| International | frequency | 0 | 11 | 18 | 17 | 24 | 22 |
| n = 92 | percent | 0% | 12.0% | 19.6% | 18.5% | 26.1% | 23.9% |
| Regional | frequency | 4 | 14 | 30 | 39 | 18 | 16 |
| n = 121 | percent | 3.3% | 11.6% | 24.8% | 32.2% | 14.9% | 13.2% |

[$X^2_{obt}$ = 13.83, df = 3, p<.01] Military vs *Ab-initio*
[$X^2_{obt}$ = 11.39, df = 3, p<.01] International vs Regional

*Investment in safety improvement* The responses to this statement suggested that military-background captains who were working in regional airlines tended to disagree that their airlines had invested a lot in safety improvement. It was noteworthy that more than one-fifth of the captains checked "strongly disagree" to the statement. There was significant difference between the captains and the first officers at the .01 level ($x^2_{obt}$ = 24.81, df = 5, p<.01). There was wide variation between the ranking (p<.01) and airline (p<.01) comparative groups: 58.3% of the military-trained pilots and 60.2% of the regional-airline pilots gave negative answers to the statement, whereas only 22.2% of the *Ab-initio* pilots and 37.8% of the international-airline pilots reported disagreement (see Table 5.10).

**Table 5.10 The Rating of the Statement: "Your company has invested a lot in safety improvement."**

| | | strongly disagree 1 2 3 4 5 6 strongly agree | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Captain | frequency | 18 | 5 | 23 | 18 | 13 | 6 |
| n = 83 | percent | 21.7% | 6.0% | 27.7% | 21.7% | 15.7% | 7.2% |
| First officer | frequency | 3 | 22 | 31 | 25 | 25 | 14 |
| n = 120 | percent | 2.5% | 18.3% | 25.8% | 20.8% | 20.8% | 11.7% |
| Military | frequency | 20 | 24 | 48 | 31 | 21 | 14 |
| n = 158 | percent | 12.7% | 15.2% | 30.4% | 19.6% | 13.3% | 8.9% |
| Ab-initio | frequency | 1 | 3 | 6 | 12 | 17 | 6 |
| n = 45 | percent | 2.2% | 6.7% | 13.3% | 26.7% | 37.8% | 13.3% |
| International | frequency | 7 | 8 | 19 | 17 | 26 | 13 |
| n = 90 | percent | 7.8% | 8.9% | 21.1% | 18.9% | 28.9% | 14.4% |
| Regional | frequency | 14 | 19 | 35 | 26 | 12 | 7 |
| n = 113 | percent | 12.4% | 16.8% | 31.0% | 23.0% | 10.6% | 6.2% |

[$x^2_{obt}$ = 24.81, df = 5, p<.01] Captain vs First Officer
[$x^2_{obt}$ = 20.25, df = 3, p<.01] Military vs *Ab-initio*
[$x^2_{obt}$ = 18.02, df = 5, p<.01] International vs Regional

An interview question was asked to assess the interviewees' willingness and opinions about attending safety conferences or meetings. Their opinions for and against participation in safety organisational meetings are summarised below:

**Table 5.11 Reasons for attending and not attending aviation safety conferences**

| *Reasons for attending aviation safety conferences:* (n = 25) | *No. of respondents* |
|---|---|
| • It helps to increase knowledge. | 12 |
| • There is no influence on flight training. | 8 |
| • Safety meetings themselves are attractive. | 5 |
| • It helps to improve language ability. | 5 |
| • It helps to better understand updated studies, regional differentials and current concerns. | 4 |
| *Reasons against attending aviation safety conferences:* (n = 25) | *No. of respondents* |
| • Language gap: There is lack of involvement due to inability to comprehend and discuss. | 19 |
| • Workload increase: The participant is required to file a report right after the meeting. | 14 |
| • Flight pay decrease: Flying hours are reduced for attending meetings, but some companies do not compensate the participant for the loss of flight pay. | 8 |
| • Attending meetings are viewed as an extra but unnecessary job. | 6 |
| • Time arrangement of these meetings is not appropriate. | 2 |

### 5.5.3 Discussion

Due to rapid expansion in the scale of their operations, some subject airlines are facing the dilemma of allocating finite resources between maximising profits and meeting safety standards. The survey results showed that a considerable number of the respondents reported negatively about resource application on safety, with regional-airline pilots being more against it than were international-airline pilots. Essentially, there are no major regulatory differences between regional and international air carrier operations. Presumably because international airlines have to face a more competitive environment (external) and there was a higher safety recognition by their top management (internal), international-airline pilots tended to be more satisfied with the safety endeavour in their companies when compared with regional-airline pilots (Safety investment: $x^2_{obt} = 18.02$, df = 5, $p<.01$; Participation in safety meetings: $x^2_{obt} = 11.39$, df = 3, $p<.01$).

Some comments made by the interviewees indicated that accident and incident investigation reports were treated as absolutely confidential, so lessons gained from them could not be learned by pilots, let alone maintenance and ground staff. Consequently, incidents were talked about amongst them in private, which is apt to be misleading and cause rumours. One interviewee stressed that "The safety staff just like to complete the investigation process as soon as possible, seldom try to take further action." The other pilot interviewed pointed out that "As learning from past accidents was almost impossible, how could learning from past incidents be expected?"

The feedback and outcome of safety efforts are not as tangible and rapid as those of production. When it comes to decision making, it is often the case that top management recognises the importance of safety but does not know how to place the priorities, and this always makes subordinates feel that top management merely pay lip service to the importance of safety. In addition, there is often an imbalance between investigation effort and remedial effort. Figure 5.6 illustrates circular procedures of accident prevention. To ensure the effectiveness of safety effort, every procedure is indispensable. In other words, only if such a safety cycle is completed, safety performance can be assured.

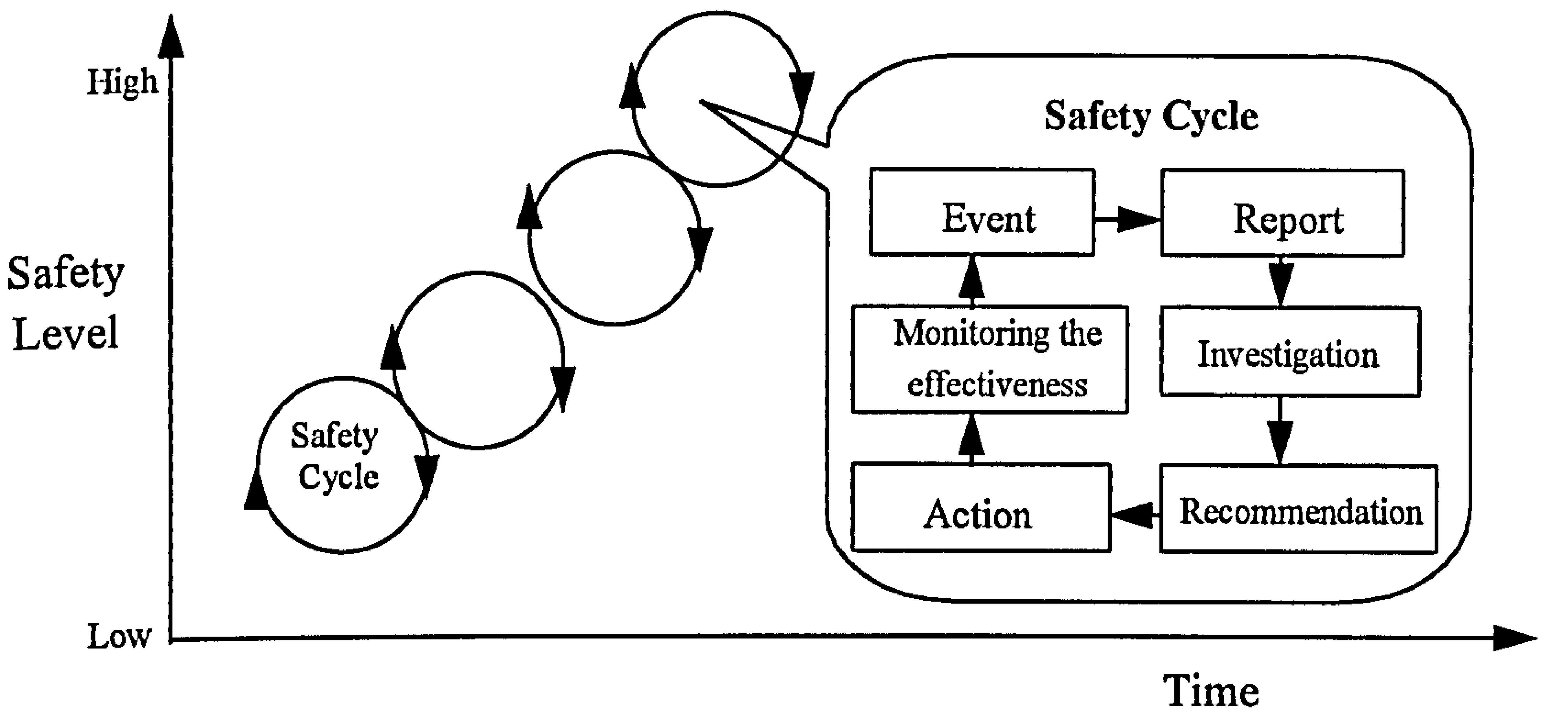



**Figure 5.6 Safety Cycle**

*Safety literature* Considering the high percentages of disagreement shown in the statements about resource availability, it is suggested that appropriate safety literature should be offered and subscribed, and that management and pilots should be encouraged to attend safety seminars or conferences. Any (and every) notice of safety information should be distributed to all employees as quickly as it is determined to be relevant. Only in this way is it possible to educate and create a continuous awareness of potential hazards.

*Establishment of a safety information network* Establishing a safety information network is an effective and essential safety management tool, which includes four main directions: participation in industry safety activities, safety information exchange, flight safety database, and statistics and trend analysis. Properly administered, it makes everyone in the organisation safety-conscious, and the safety information network should be totally "transparent". That is, everyone should have access to safety information throughout the entire organisation. Trend analysis gives everyone a glimpse of "how we are doing" in safety performance and can be a powerful motivational tool.

## 5.6 The role of the civil aviation authority in airline safety

### 5.6.1 Introduction

When considering air travel risk, the safety/risk levels established by regulatory authorities are usually the minimum acceptable (ICAO, 1984). The quality of a national aviation regulatory authority has a direct impact on safety. If the authority is not working at peak efficiency, safety can become impaired. If the authority mismanages its meagre guidance and enforcement resources, it might have to rely heavily on the good faith of the regulated companies to comply with safety rules.

In most countries, the civil aviation authority has the responsibility of achieving a high standard of safety. It usually undertakes this by formulating regulations and procedures based on ICAO SARPs[25] (Standard and Recommended Procedures), tailored where necessary to meet local environmental or operational conditions. Inspection and enforcement processes are then established to ensure that the aviation community complies with the national regulations.

### 5.6.2 Respondents' perception of the role of aviation regulatory authority

This section deals with the pilots' opinions about the role of the aviation regulatory authority in the subject countries. The majority answered negatively about the CAA's performance in terms of response to the pace of technological change, checking compliance with safety standards, capacity to guide airline training, provision of safety information, and investigator's qualification for dealing with advanced aircraft. A point of particular interest was that two-thirds of pilots did not feel that the investigators were qualified to the level required for advanced technology aircraft (see Figure 5.7).

[25] When countries cannot, for whatever reason, adapt their national legislation to conform to ICAO SARPs, they are required to file a "difference". This is published by ICAO, and indicates to other countries, and users, that their legislation differs from internationally agreed standards.

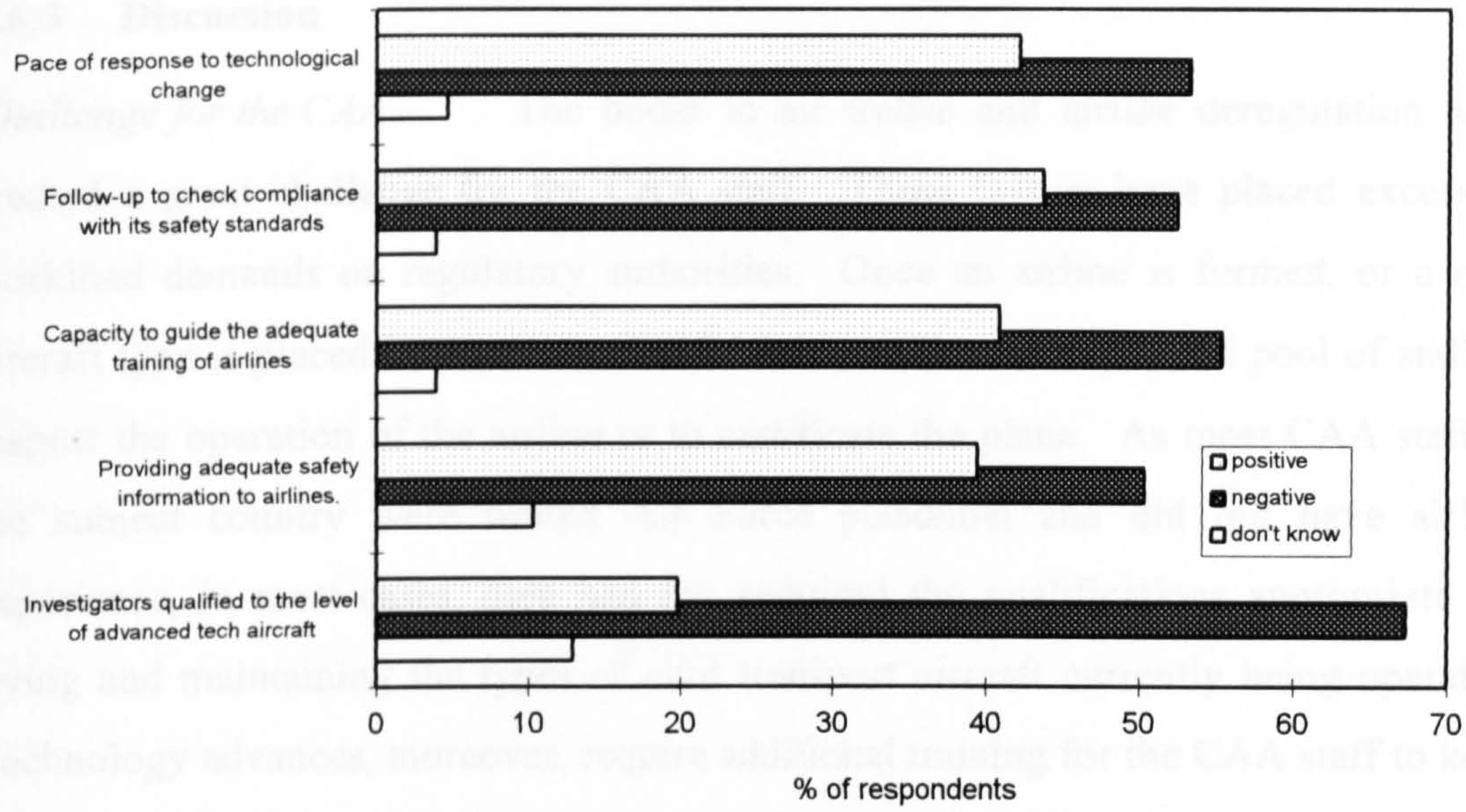



**Figure 5.7 Pilots' Perceptions to the Role of Their National Aviation Regulatory Authorities**

Significant differences regarding compliance with safety standards [$\chi^2$ (5, N=233) = 13.62, p<.05] and guidance of training [$\chi^2$ (5, N=233) = 20.88, p<.001] were found between captains and first officers. Some other information from Asian management pilots and CAA officials is shown in Table 5.11 It is obvious that there is a wide variation between pilots' perceptions and CAA officers' self-assessment.

**Table 5.12 Respondents' Perceptions of the Role of Aviation Regulatory Authority** (Percentage of Disagreement)

| | Asian Pilots | CAA officers |
|---|---|---|
| Response pace to technological change | 41.8% | 23.5% |
| Compliance check with safety standards | 39.1% | 17.6% |
| Capacity to guide the training of airlines | 47.8% | 23.1% |
| Provision of safety information to airlines | 50.8% | 18.7% |
| Investigator's qualification to advanced aircraft | 69.6% | 29.4% |

When asked about the necessity of setting up an independent aircraft accident investigating agency, 21 of the 22 CAA officers agreed and only 1 disagreed. The reason for objecting to the idea, as indicated by the individual concerned, was that his country was small. Considering the finite resources available and the small size of the aviation community in his country, he did not think there was a need to establish an independent investigating agency.

### 5.6.3 Discussion

*Challenge for the CAA* The boom in air traffic and airline deregulation have created a great challenge for the CAA staff. These factors have placed excessive workload demands on regulatory authorities. Once an airline is formed, or a new aircraft type is placed into service, the CAA has to devote its limited pool of staff to inspect the operation of the airline or to certificate the plane. As most CAA staff in the subject country were retired Air Force personnel and did not have airline experience, in most cases, they had not acquired the qualifications appropriate for flying and maintaining the types of civil transport aircraft currently being operated. Technology advances, moreover, require additional training for the CAA staff to keep abreast of recent technological developments, such as new navigation systems and computerised flight control systems. Time constraints have made it difficult for the CAA staff to augment their qualifications in newly operated equipment and knowledge of airline operations. In addition, the number of staff employed has declined. This may possibly be because a flight- or maintenance- qualified person can get a higher paying but lower workload job with the airlines.

Excessive workload demands as well as staff shortages have resulted in overreliance on reviewing paperwork. Such a "pencil whipping" phenomenon has raised concerns in the aviation community. Several interviewees have stated that "the CAA should have larger budgets to enhance the salary of civil aviation officials and reinforce necessary training" in order to encourage them to stay with the CAA and, moreover, to create incentives for young people to enter the profession as a desirable career.

Another situation to have been aggravated by the workload problem was the inability to revise and update the Civil Aviation Regulations in order to meet current needs. The interview and questionnaire results showed that there was great call for updating of the Civil Aviation Regulations. Many interviewees and pilot respondents stated that "The Civil Aviation Regulations should be continuously revised to meet current international standards."

*Recommendations for the existing problems* To address the problem of staffing in the interim, the CAA is recommended to consider tapping into the sizeable pool of experienced technical, managerial and regulatory experts now available within the international aviation industry and community. With regard to setting up an independent accident investigating agency, the majority of the subject countries could not afford to establish their own although great intentions were shown in the survey. Considering the lack of experts, insufficient facilities and limited budgets in the subject countries, cross border co-operation with countries that possess qualified accident investigation agencies is suggested to obtain help in dealing with international accidents and their own domestic ones as well. As noted in Section 2.3.3, such international co-operation should start with a willingness to establish the channel of communication and a commitment to participate in the development of the required procedures.

As a long-term solution to manpower shortage, professional training is recommended to provide and augment staff qualifications, and hopefully to increase their job satisfaction. Additionally, salary differentials between civil service positions and airline jobs needs to be narrowed to encourage a career with government-base civil aviation. It is suggested some form of additional pay on top of the base civil service salary should be provided when an individual remains in his job and maintains a high level of performance.

Many respondents indicated there was need to update Civil Aviation Regulations. However, it is a slow process, due in part to legal constraints imposed by changes to legislation, and more often than not, because of lags resulting from the failure recognise the need for remedial action. Figure 5.8 illustrates how considerable time lags can occur before changes to regulations can be made and implemented. As an interim measure, the CAA could act as an informant by publishing advisory circulars to highlight the lessons learned from accident and incident investigations, and hopefully to help avoid these weaknesses in the future.

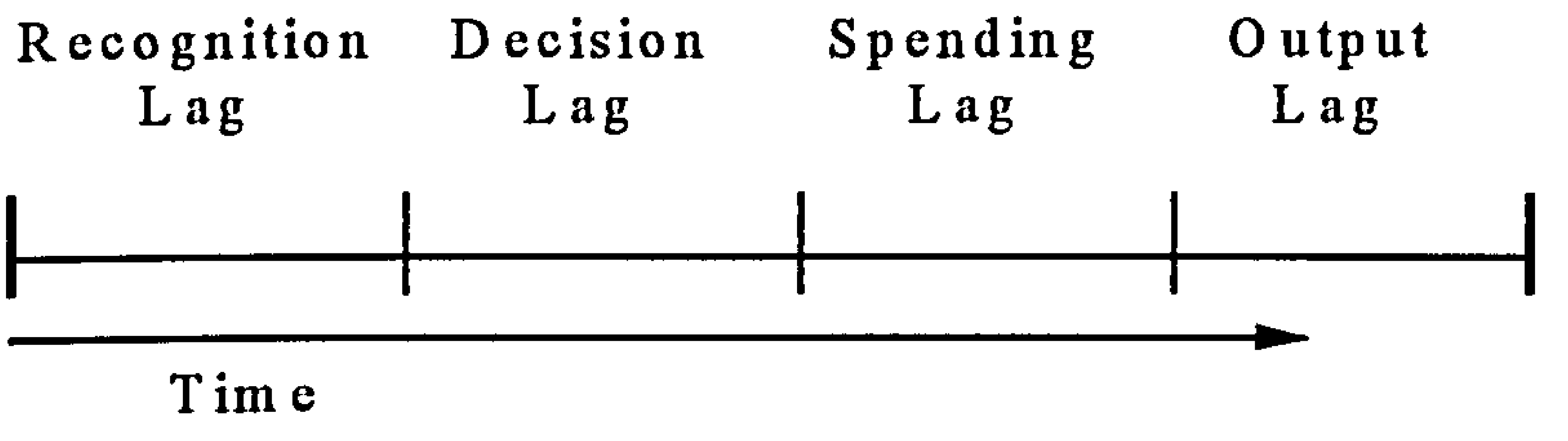



**Figure 5.8 Four Implementing Lags**

The most fundamental change that is required is to build up the concept of partnership for safety. Surveillance and oversight of airline operations by the national authority is an essential part of ensuring safety. Sometimes the goal of preventing the accident in the first place is forgotten. Rather than acting in a police/punishment fashion, the CAA should act as an authority in partnership with the operators on accident avoidance, while still retaining the ultimate prerogative of applying appropriate punishment when necessary.

## 5.7 Language disadvantages for non-native English speaking pilots

English is the formal language of commercial aviation. For most Asian countries, it is one of the most essential requirements in pilot selection. Not only is English vital for verbal communication during training and operations in the cockpit, but it also influences the transmission and sharing of safety information. Numerous studies have explored the problems of linguistic intervention (Billings and Cheaney, 1981; Monan, 1988, 1983), yet few examine the difficulties of language barriers. This section discusses the frustrations resulting from language barriers, which cause difficulties in communication and co-operation, and also influenced the reception of safety information.

Some clues regarding language barriers have been revealed in Section 5.2. Others are presented as follows:

More than one-third of the respondent pilots agreed that they suffered a language gap on receiving safety-related information (see Table 5.12 ).

**Table 5.13 A Language Gap for Receiving Safety-Related Information**

| | Taiwanese pilot | Asian MGT pilot |
|---|---|---|
| Yes | 41.9% | 37.1% |
| No | 36.0% | 50.1% |
| Don't know | 22.1% | 12.8% |

Interview results also showed that communicative difficulty was a leading problem when training abroad. 57.1% of the interviewees indicated that poor language proficiency hindered them from asking questions, and 78.6% admitted that it influenced their learning speed. Here is a typical example stated by an interviewee:

> *"...I remembered when the first time I was training abroad. Because the instructor spoke too fast with a special accent and it was the first time for me to be trained in this type of aircraft, I not only didn't totally understand what he said but also didn't know how to ask questions and express my opinions."*

Some interviewees mentioned that language barriers could create confusion, hesitation and frustration with regard to co-operation in the cockpit.

> *"Crew often discuss technical problems in their native language, leaving the English-speaking Captain out of the loop."*
>
> *"Greater effort and concentration are required to avoid confusion, and that surely would influence their focus on aircraft monitoring."*
>
> *"In brief, my English proficiency is the biggest obstacle and frustration in the cockpit. Hesitation to ask questions never happens to me, but I would not ask the same question for the third time if I still did not get it. I would rather bear in mind with confusion."*

Language barriers were not only a serious issue in both training and operations, but also caused problems regarding the interpretation of safety information. 32.1% of the interviewees expressed that they had ever misunderstood the meaning of the operating manual due to language gap. Below is a critic description from a First Officer interviewed:

> *"My Captain's English is not good enough, but because the operating manual is written in English, he likes to make judgement by his past military experience and concepts."*

Merritt's research (1995) pointed out that the first frustrations of a multinational crew were with language barriers, which accorded with the findings of this study. However, there was a difference, in that the majority of the subjects in her research were from English-speaking countries, while this study aimed at non-native English speaking pilots.

The results of these two studies revealed that language barriers caused difficulties in the cockpit for both native and non-native English speaking pilots. While non-native English speaking pilots might have difficulty communicating in other than their first language, native English speaking pilots tended not to be able to communicate clearly and precisely with non-native English pilots as they could be unaware of and insensitive to the difficulty of encoding and decoding information in a second language.

In addition to being used as the main language for communication in flight operations, English is the essential language for many aviation safety literature. Lack of multilingual people to translate foreign safety articles and documents into their own languages has made the subject airlines unable to provide imminent safety information for their staff. It is, therefore, understandable that many pilot respondents, as shown in Sections 5.5 and 5.6, requested for the provision of more aviation safety information.

The following suggestions are made for top management regarding the management of language barriers:

1. Recognise the existence of language barriers on training, operations, and the transmission of safety information;
2. Encourage and provide opportunities for the further improvement of English for aircrew;
3. Suggest and encourage the use of English in the cockpit at all times except in the case of an emergency;
4. Encouraging expatriate pilots to use simple and plain English in the cockpit;
5. Through safety meetings or CRM training, let expatriate pilots understand the linguistic difficulties and problems local pilots have;
6. Increase the availability of bilingual manuals and regulations: These help to prevent misunderstanding or conjecture. However, it is suggested that any bilingual manual or regulation be thoroughly checked before being published. This will help to ensure appropriate translations and avoid misinterpretation; and
7. Establish language clinics to provide assistance for language problems: Hiring of a few fluently multilingual people could be very beneficial, especially if these people can be assigned to provide appropriate translations of foreign safety articles and documents. Then, concepts and ideas for safety strategies can be widely discussed and shared among the staff. Alternatively, another source of such help could be found in universities, where faculty and students who possess the required language skills could be utilised (and at the same time become interested in aviation as a possible career). Tapes with real-life recordings should be utilised in language labs. They could also be used in LOFT training to replace the synthesised recordings currently used.

## 5.8 The perception of important factors to airline safety

Respondent pilots' and CAA officers' assessments of the relative important factors to airline safety are summarised in Table 5.13 and 5.14 in the form of mean rankings (higher mean rankings indicate the factor is perceived to relatively more important).

**Table 5.14 Mean Ranking of Factors According to Respondents' Perceived Importance to Airline Safety** (Taiwanese pilots)

| | Mean Ranking (s.d) | | |
|---|---|---|---|
| | Captain<br>n = 94 | First officer<br>n = 139 | All pilots<br>n = 233 |
| Top management | 5.54 (0.86) | 5.50 (0.78) | 5.52 (0.82) |
| Training | 5.57 (0.68) | 5.81 (0.48) | 5.79 (0.57) |
| Organisational structure | 4.72 (1.09) | 4.59 (0.97) | 4.64 (1.02) |
| Organisational culture | 5.17 (1.17) | 4.93 (0.89) | 5.03 (1.02) |
| Operating standard | 5.69 (0.82) | 5.73 (0.57) | 5.72 (0.68) |
| Resource management | 4.63 (1.25) | 4.92 (1.01) | 4.80 (1.12) |
| The role of CAA | 4.04 (1.67) | 4.54 (1.28) | 4.34 (1.47) |

**Table 5.15 Mean Ranking of Factors According to Respondents' Perceived Importance to Airline Safety**

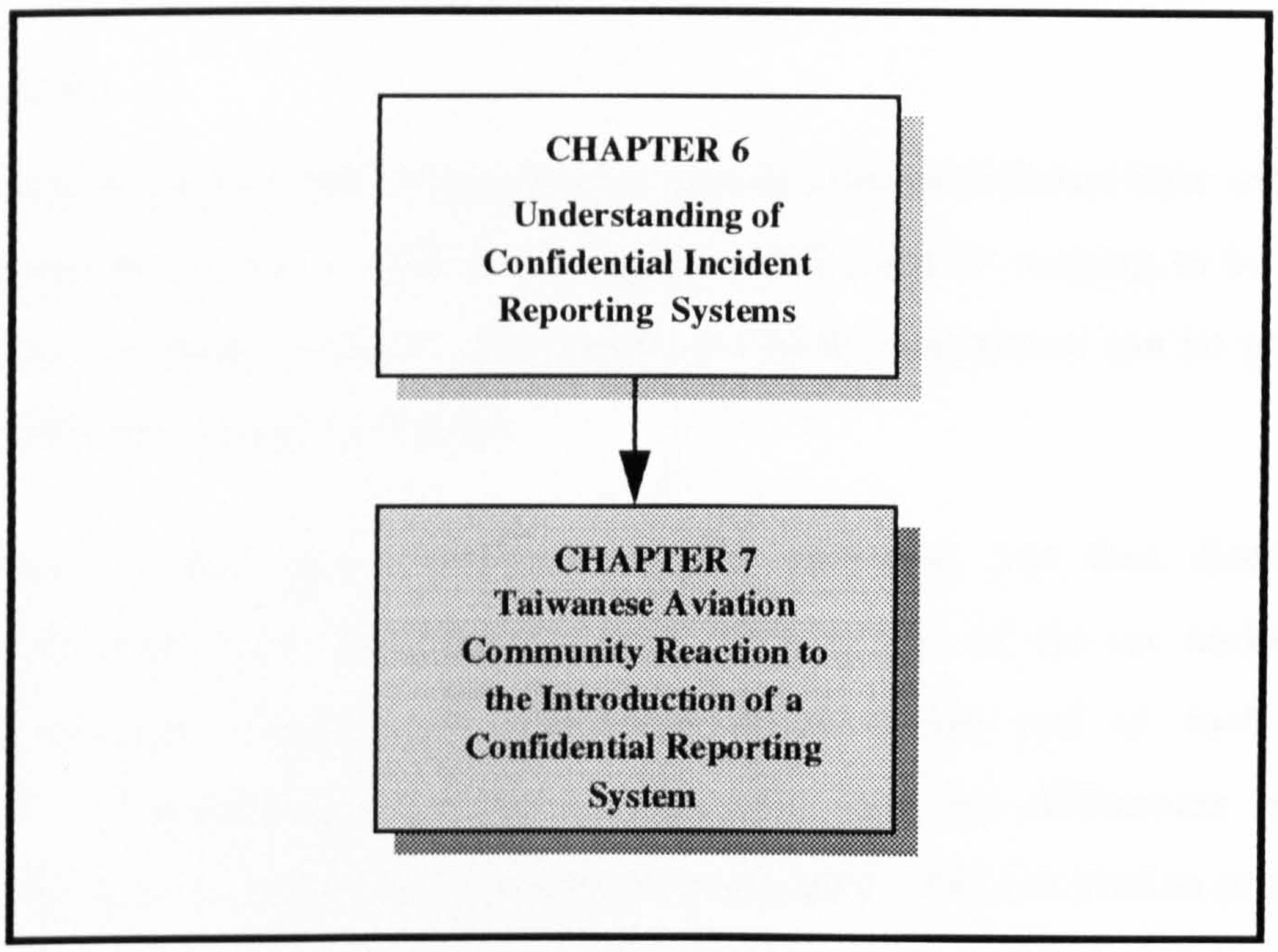
| | Mean Ranking (s.d) | |
|---|---|---|
| | Asian MGT pilot<br>n = 46 | Asian CAA officer<br>n = 22 |
| Top management | 5.54 (0.66) | 5.68 (0.65) |
| Organisational structure | 5.15 (0.89) | 5.05 (0.84) |
| Organisational culture | 5.22 (0.84) | 5.45 (0.74) |
| Operating standard | 5.85 (0.36) | 5.36 (0.73) |
| Training | 5.80 (0.40) | 5.55 (0.60) |
| The role of CAA | 4.76 (1.25) | 5.18 (1.01) |

Analysis was conducted using repeated measures ANOVA in order to investigate individual differences in the perceived factors concerning airline safety. The possible influence of the current position and the initial training background of the respondent pilots was also assessed in the ANOVA (Taiwanese pilots). A significant main effect was observed within individuals across the alternative factors ($p<.001$, $F=52.08$, $n=233$, df 6, 1374) No significant effects were observed for the position of the respondent pilots (F=0.46, NS, n= 233, df 6, 1374) or the initial training background (F=0.42, NS, n= 233, df 6, 1374). (see Appendix H: the summary table of the repeated measures ANOVA.) Subsequent post hoc testing using multiple t-tests (see Appendix H) revealed significant individual differences in perceptions of the importance of factors in airline safety with flight training perceived to be significantly important than organisational structure (t=17.53, p<.001, n= 233, df= 232), organisational culture (t=11.97, p<.001, n= 233, df=232), resource management (t=14.15, p<.001, n=233, df=232), and the role of CAA (t=14.46, p<.001, n=233, df=232). Operating standard was also considered to be more important than organisational structure (t=15.66, p<.001, n= 233, df=232), organisational culture (t=11.15, p<.001, n=233, df=232), resource management (t=13.38, p<.001, n =233, df=232) and the role of CAA (t=13.70, p<.001, n= 233, df=232).

Flight training and operating standard were perceived as more important factors to both Asian and Taiwanese respondent pilots, while top management was viewed as the most important factor in the viewpoint of CAA officer respondents. Analysis of all respondent groups showed that the role of CAA received the lowest mean ranking in all of the factors analysed (see Table 5.13 and 5.14).

# PART III

## Feasibility Study for a Confidential Aviation Incident Reporting System in Taiwan




**Despite the improvements in hardware and facilities in the aviation industry, the incidence of human error has remained persistently high. Hence, safety issues focus on better understanding of how people perform their assigned duties, and safety professionals claim that accident prevention should start with rooting out the underlying causal factors or incidents as mentioned in Chapter 3. This requires analytical systems sensitive enough to provide early identification and warning. It is believed that a confidential incident reporting system is one of the necessary tools, enabling hasards to be constantly tracked and evaluationof the risks they involve.**

# CHAPTER 6

# UNDERSTANDING OF AVIATION CONFIDENTIAL INCIDENT REPORTING SYSTEMS

"We never learn enough from accidents, let alone our incidents."

-------- Gerry Bruggink

## 6. Overview

Lauber (1984) discusses the safety research uses of aviation incident data, stating that an incident database "is a veritable gold mine of information waiting to be tapped." This chapter examines how this 'gold mine' of safety information can be gouged by using confidential reporting systems.

It first explores the need to establish incident databases, and then discusses the strengths and limitations of using the data. The review of the six national-level reporting systems follows, with comments added at the end of each section. Similarities in underlying structures are described and the differences in details among these selected operational systems are compared. The last section presents the vital concept of data exchange for future developments.

## 6.1 The need for an incident data base

In comparison with accidents, the characteristics of incidents discussed in Section 3.3.4 depict the benefits of accumulating aviation safety incident information in terms of the frequency of occurrence, the severity and visibility of events. Incident data can permit early identification of problems in the aviation system and allow effective remedial action before they result in an accident.

For individuals, the valuable information gathered from incident reports makes them aware of unsafe acts and prevents them from making similar errors with perhaps fatal consequences. Also, incident data often provides organisations in the aviation industry the opportunity to increase safety and learn from each other. It assists airlines to assess the existing operational system and make changes in safety management. Using and circulating incident data, in addition, helps aircraft manufacturers to achieve the design of more error-resistant aircraft. The data may also aid aviation regulatory authorities in modifying safety regulations.

In order for enhance accident investigation and prevention, the eighth edition (July 1994) of Annex 13 (Aircraft Accident and Incident Investigation) of ICAO recommends to its member states several new provisions. Two of these provisions are relevant to incidents, which includes:

- the requirement to establish incident reporting systems.
- a requirement for the investigation of serious incidents, and

The need of an incident data base is well explained by Ashford (1994) who stated at a safety conference, "Too often an accident occurs where a particular failure or inadequacy is involved and it is later recognised that this same aspect was a factor in earlier incidents or accidents, but the chain of communication failed somewhere between the occurrence and the corrective action. Not to have taken adequate and timely action earlier means that the later accident was avoidable and industry and authorities can be criticised for the lack of earlier action." Incident data provides a way to prevent accidents by identifying the developing causal chain and allowing effective remedial action to be taken before the causal factors result in an accident.

## 6.2 The phenomenon of the problem

Pidgeon and O'Leary (1995) claim that achieving maximum benefits from an incident reporting system is dependent on direct access to top management and open exchange of safety information. In an ideal organisation, line pilots should be able to discuss their technical, operational, crew and personal problems directly with their managers. Safety information can be exchanged openly without fear of being disciplined because of what has been reported. However, it is often the case that flight crews involved in unsafe or potentially unsafe events seldom submit incident reports involving their own performance.

The statistics of the Accident/Incident/Hazard database of Taiwan from 1990 to 1994 reveals that 65.8% of the accidents, 72.6% of the incidents, and 4.0% of the hazards are related to human performance (see Figure 6.1). As described in Section 2.6.2, it is generally conceded that almost two-thirds of the aviation accidents and incidents have their roots in human performance error. Figure 3.5 of Chapter 3 also shows that the ratio among major accidents, minor injuries and no injury incidents may be one to

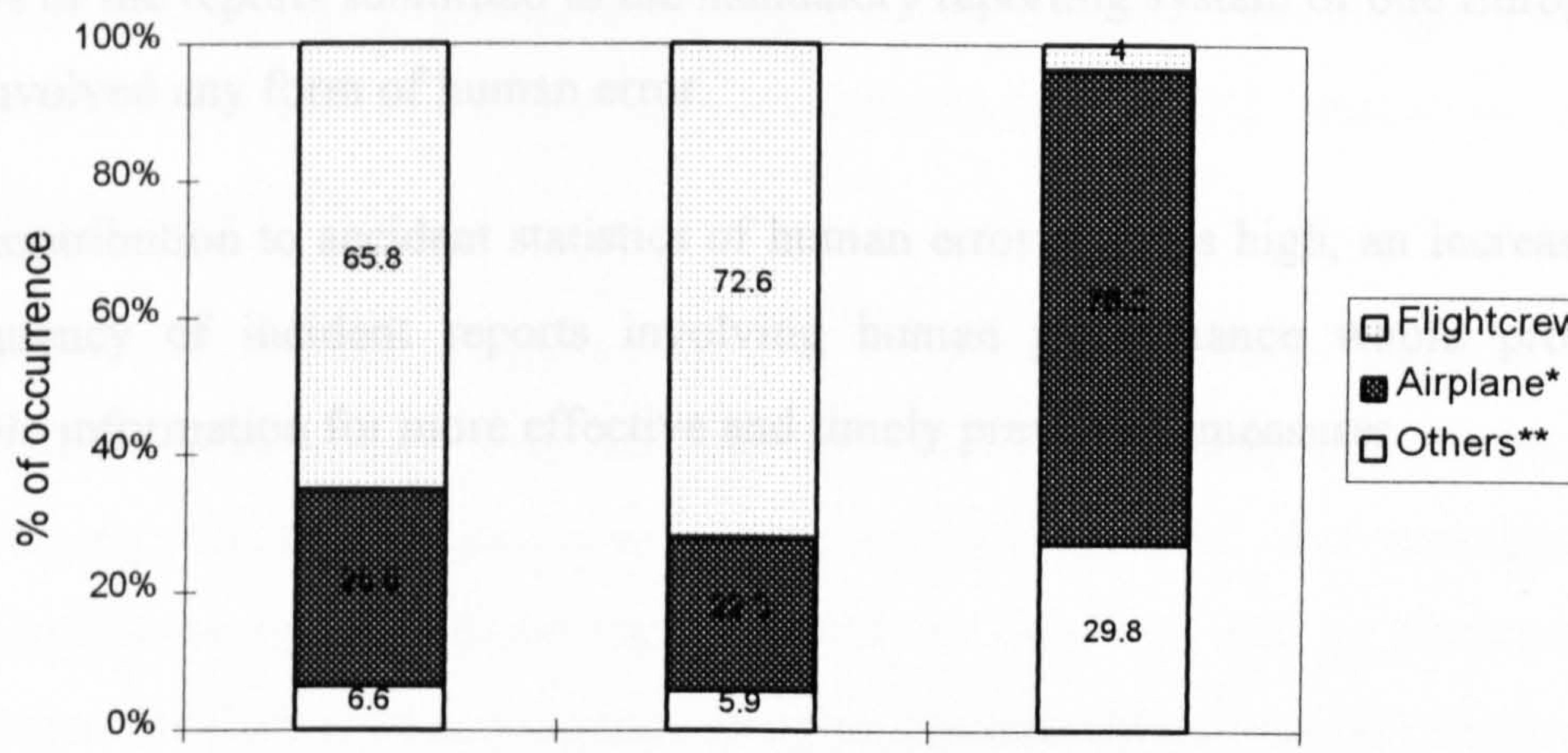



**Figure 6.1 Type of Aircraft Occurrence by Percentage of Data Set**

Source: CAA-Taiwan

* includes maintenance, ** includes weather and miscellaneous

twenty-nine to three hundred. The low percentage of hazards in Taiwan, or what is generally defined as no injury incidents, begs the question whether many incidents are not reported.

Analysis of Australian BASI's (Bureau of Air Safety Investigation) Accident and Incident database indicates a similar non-reporting phenomenon. Of the incident reports that were submitted to BASI by flight crews in 1984 and 1985, only 12% (9% General Aviation) involved any form of human error (BASI, 1988). However, an analysis of incidents reported by all sources shows that 31% of those incidents and 50% of the more serious incidents involved flight crew performance, whereas an analysis of accidents shows that 71% involved flight crew performance. These figures not only reveal that many incidents involving flight crew performance may not be reported[26], but also show that there is a relationship between accidents and incidents.

The reporting system of European Regional Airline Association (ERA) also has the difficulty of getting crew performance type incident reports, because almost 75% of reports filed were related to technical rather than operational occurrences. Even though some nations require a mandatory reporting of all incidents, the number of human unsafe acts that were reported was minimal. Green (1995) indicated that only about 2% of the reports submitted to the mandatory reporting system of one European nation involved any form of human error.

As the contribution to accident statistics of human error remains high, an increase in the frequency of incident reports involving human performance would provide invaluable information for more effective and timely preventive measures.

[26] BASI indicates that the non-reporting of incidents predominantly involves 1) flight crew, 2) incidents involving flight crew performance, and 3) incidents that are known only to flight crew.

## 6.3 The strengths of using confidential incident data

*Benefit to safety management* Incident data has provided aviation professionals with information to collaborate on solutions to safety problems: operating procedures and policy have been made and refined; aircraft design modified; training programmes developed on the basis of realistic occurrences; research has been conducted in determining the possible scope of the problems and providing direction for remedy; basic human performance associating with the operation of aircraft and air traffic control was better understood (Lyall, 1992; Chappell, 1994). Modifications to BAC 1-11 fuel selection switches exemplify the situation. An incident involving mis-selection of the fuel switches of a BAC 1-11 was reported to UK Confidential Human-factors Incident Reporting Programme (CHIRP). After the publication of this incident in the *Feedback* newsletter produced by CHIRP, several other BAC 1-11 pilots reported having suffered similar engine flameout due to mis-selection of fuel switches. As a result, UK Civil Aviation Authority (CAA) undertook an ergonomic study of the BAC 1-11 fuel selection switches and modified the switch design before it led to an accident.

Incident data is also valuable in creating concerns over safety issues within an airline. Based on actual occurrences, risk assessment may be more accurate and training programmes are likely to be more effective. For example, simulation training scenarios constructed from realistic incident data, such as LOFT, tend to be taken more seriously by pilots.

*Great volume and diversity of information* Though aviation accidents are investigated more thoroughly than incidents and thus provide many valuable lessons, the limitations of small samples exist when using accident data. For example, the wrong conclusions may be drawn because relatively little data can be obtained for investigators to validate what happened exactly. Because of no survivor to provide detailed information, the main cause of the explosion of TWA Boeing 747 Flight 800 occurring on 17 July 1996 was still unclear at the time of this writing even though the investigation team had found the Flight Data Recorder (FDR). We stand little chance of discoverilng all the causal factors in this accident. Incident data, on the contrary, offers a large quantity of detailed information provided by the participants in the events. The availability of large numbers of incident reports on many topics provides investigators and researchers with a clear picture of problem areas and allow them to conduct follow-up laboratory research.

The UK CHIRP BAC 1-11 fuel management problem mentioned above is a good example of how beneficial incident frequencies can be in revealing the latent failures in the system. One report of unsafe acts in a particular aircraft type can easily be attributed to pilot error, but multiple reports of the same incident should bring the matter to the attention of aviation safety professionals.

*More thorough learning* Incident data provides detailed information for direct studies in solving operational or training problems. It is very beneficial to be able to review similar incidents and seek solutions to prevent the incidents from becoming accidents in specific situations. The following two cases are the examples of how incident reports were used to evaluate the efficacy of new warning systems. Despite reported false alarms from the ground proximity warning system (GPWS), the warnings were evaluated as effective in preventing aircraft from striking the ground (Loomis, 1981), so GPWS were still mandated for airline aircraft in the United States. Another study by Mellone and Frank (1993) revealed that the false alarms of the Traffic Collision Avoidance System (TCAS II) affected the air traffic control system. As TCAS II was mandated for airline aircraft in the United States, some airports had to modify their air traffic arrival and departure procedures to accommodate aspects of the system in order to reduce the number of false alarms (Chappell, 1994).

Additionally, incident data provides first-hand information from the participants in the events which often is not available following an accident. When necessary, the submitted information can be augmented and clarified and compared between the flight crew and the participating air traffic controller in order to identify potential hazards.

## 6.4 The limitations of using confidential incident data

Many of the problems result from the characteristics of the incident reporting system: the voluntary and confidential nature of the reporting process, and the corresponding granting of immunity and anonymity to the reporters. The ability to substantiate incident reports is addressed first, followed by biases and misperceptions on the part of the reporter, and statistical inference when using the database.

*Factual occurrence not verified* Few countries or organisations fully investigate incident reports. Even though some do, the confidentiality of the system and the anonymity granted to reporters may preclude any additional investigation to validate information objectively and reports are thus unverified. In addition, the limits of time and budgets in dealing with a large number of incident reports prevent a thorough investigation on a special topic. A passive way to check the validity of information is to examine the consistency of multiple reports on a particular topic. However, it is also possible that a large number of reporters may embellish, exaggerate or report erroneous data in order to benefit themselves, to understate their errors and blame the occurrence on other parties.

For example, the controllers at an airport tower facility may inflate the number of traffic conflicts to support the addition of radar, which would result in an increase in their salary (Chappell, op. cit.). Nevertheless, it is likely that experienced report analysts detect any apparent reporting bias and reflect their suspicion in the analyses of those reports.

*Reporting biases* In addition to the validity of subjectively reported information, several factors may contribute to potential bias in the incident data. Not all pilots, controllers, air carriers, or other participants in the aviation system, are equally aware of the incident reporting programme or equally willing to file a report. The incident programme and the reporting forms are more accessible for members of the aviation community. Other pilots and controllers who are not members of the organisations may not be motivated to report. Even if some of them are familiar with the programme and want to submit reports, they may find it difficult to contribute safety reports. Take US Aviation Safety Reporting System (ASRS) as an example. Pilots contribute 95% of the safety reports (64% air carrier pilots; 27% General Aviation), while only 4% of the reports are received from air traffic controllers (ASRS, 1996). This imbalance causes the ASRS database to have more pilot-error records (altitude deviations, runway transgressions, etc.) than controller-error records (operational errors, co-ordination failures, etc.).

Furthermore, the immunity offered to contributors affects reporting. As airline pilots are suggested to greater monitoring by human and electronics means, they are apt to submit reports of operational problems in order to receive immunity for their deviations with more regularity than general aviation pilots who do not fly professionally. For example, with the establishment of Error Detection Programme (EDP) in the United States, loss of separation was recorded automatically by the computer. As a result, greater numbers of pilots began to report their altitude deviation with the purpose of receiving immunity.

On the contrary, if an individual feels that there were no significant consequences resulting from the error and regulatory immunity is not needed, he may not report his own error. In other words, errors that go undetected are not likely to be reported. Not all non-significant errors are not reported. If an individual makes an error and the error might create problems for another, the latter may then notify the incident reporting programme of the event.

*Statistical limitation* Using incident report information should be treated into caution. As described above, confidential reports are difficult to validate objectively, and reporting biases may affect the type and the number of reports received, and thus distort the statistics of incident data. Lyall (1993) points out that "incident data are very valuable in giving examples of specific occurrences, but should not be used and reported as summary statistics". When drawing conclusions from the analysis of incident data, one should realise that the reports are not necessarily representative of the full population of events. The example of altitude deviation reports described above shows that the number of reporting the event increased after the establishment of EDP, yet there is still no knowledge of the total number of occurrences. The number only represents the lower measure of the true number of such events which were occurring. Wickens (1993) recommends that augmenting the data base by integrating it with others is likely to uncover critical hazards that are under-reported.

## 6.5 Analysis of US, UK, Canada, Australia, New Zealand, and Germany incident reporting systems

A confidential incident reporting system was first introduced in the seventies by the US Federal Aviation Administration (FAA). The UK, Canada, Australia, New Zealand and Germany then followed. In addition to these national-level reporting systems, many airlines have internal reporting programmes of their own. This section merely focuses on national-level reporting systems. Further discussion is offered to describe the extent of implementing mandatory reporting systems. The main purpose of this section is to examine these confidential reporting systems in terms of the origin, confidentiality, immunity, feedback publications, information focus and procedural details. Although none should be regarded as a precise model for a Taiwanese system, they do provide valuable insight into the ways to operate an aviation safety reporting systems, especially in acquiring data concerning safety events.

### 6.5.1 US Aviation Safety Reporting System (ASRS)

#### 6.5.1.1 The first national level confidential incident reporting system

On 15 April in 1975, less than 5 months after the crash of Trans World Airlines (TWA) Flight 514 into a Virginia mountaintop, the US Federal Aviation Administration (FAA) initiated the first national confidential Aviation Safety Reporting Programme (ASRP) with the hope of offering to the aviation community information to eliminate unsafe conditions and prevent avoidable accidents. As the FAA was the regulatory body for aviation, potential reporters distrusted its neutrality. Thus, the scheme was not successful. The problem was solved by transferring the sponsorship to a neutral and independent third party - the US National Aeronautics and Space Administration (NASA). Under the 1975 Memorandum of Agreement between NASA and the FAA, FAA's responsibilities included funding the programme and providing disciplinary immunity for pilots, while NASA is responsible for setting programme policy and administering operations. The name of the system was then changed to the Aviation Safety Reporting System (ASRS).

ASRS accepts reports from pilots, air traffic controllers, and others who witness or are involved in an unsafe occurrence or hazardous situation. To encourage candid reporting, ASRS guarantees confidentiality to the reporter because many reported incidents involve violations of Federal Aviation Regulations (FAR) by the person making the report. In addition to a guarantee of confidentiality, reporters to ASRS are granted use immunity[27] from FAA action, provided (NASA, 1993):

1. reports are submitted to ASRS within ten days of the occurrence;
2. the occurrence did not involve a criminal act;
3. the occurrence was not an accident as described by the Code of Federal Regulations (49CFR 830); and
4. the person submitting the report as not been found guilty of violating any FAR within the preceding five years of the date of the incident being reported taking place.

The FAA also granted transactional immunity to the reporter in conjunction with unintentional errors. It waives fines and penalties (subject to certain limitations) in exchange for a candid account of the human errors that posed a threat or potential threat to aviation safety. Transactional immunity is a powerful incentive for reporting an unintentional violation, but it is not as significant a factor to controllers as pilots because controllers are subject to FAA directives and their operational errors have rarely resulted in permanent loss of air traffic control certification.

### 6.5.1.2 The US mandatory incident reporting requirements

The aviation community in the USA is legally required to report only six types of incident to the National Transportation Safety Board (NTSB). The six types of incident are:

- flight control system malfunction or failure;

[27] FAR 91.25 Aviation Safety Reporting Programme; prohibition against use of reports for enforcement purposes. The Administrator for the FAA will not use reports submitted to the National Aeronautics and Space Administration under the Aviation Safety Reporting Programme (or information derived therefrom) in any enforcement action, except information concerning criminal offences or accidents which are wholly excluded from the Programme.

- inability of any required flight crew member to perform normal flight duties as a result of injury or illness;
- failure of structural components of a turbine engine excluding compressor and turbine blades and vanes;
- in-flight fire;
- aircraft collision in flight;
- aircraft overdue and believed to have been involved in an accident.

Regardless of the mandatory reporting requirement, any person found by the FAA to have been involved in breaking a FAR can be fined or penalised resulting in loss or suspension of certification.

Aviation incident data is, as described above, of importance in providing valuable information for the improvement of safety of aircraft operations, especially the human performance type incident data. Nevertheless, the small proportion of human performance reports received by the mandatory system indicates the need to set up a non-punitive reporting system in order to complement the US mandatory incident reporting system. ASRS was thus established to elicit all types of incident reports, in particular human performance type.

#### 6.5.1.3 The report process

The process of ASRS reporting mainly comprises of five phases: Reporting, comprehensive procedures, de-identification, data entry and storage, and information feedback.

*Reporting* Any person observing or participating in an aviation safety incident may file a report with ASRS. Reports may be submitted on official reporting forms distributed by NASA or by phone calls.

*Comprehensive procedures* Reports are scanned to distinguish incidents from criminal activities and accidents. A report involving criminal behaviour is sent to the Department of Justice, whereas a report considered to outline an accident is sent to the NTSB. Each incident report is examined for adequacy, then coded with a database input form for computer searching and visual scanning, and matched with other reports of the same incident. If necessary, analysts will contact by phone the person who submitted the report to clarify the nature of the incident and to obtain more detailed information.

*De-identification* The reporter is required to provide his or her name, address and contact phone number on the tear-off slip of the reporting form. If the report is considered to be clear and complete, the name and address slip is removed from the report and mailed back to the person who submitted it within seventy-two hours of receipt of the report. The identity slip with the NASA-received date stamped on it then becomes the individual's receipt and evidence of entitlement to immunity from FAA disciplinary action. This is known as de-identification. No information that may be used to identify any individual or company associated with the incident are kept. De-identification of reporters involves analysts removing from the records of names addresses and phone numbers, whereas de-identification of incidents is to remove any reference to flight numbers, specific routes or locations, company names, and specific aircraft make and model information. In other words, the de-identified report provides a verbal explanation of what happened and in many cases even why it happened, but not where, or to whom it happened.

*Data entry and storage* The reports are then keyed into computer database. Records in error are corrected and resubmitted. Successful records are automatically indexed, with terms and word patterns entered into the BASIS inverted files for retrieval.

*Information feedback* The information feedback to the aviation community about lessons learned by reporters is considered vital to encourage reporting and enhance safety awareness. ASRS disseminates its outputs in three ways: distributing feedback publications, dealing with search requests, and conducting research.

1. ASRS publishes a monthly bulletin, *Callback*, and a periodic journal, *Directline*. In addition, it also issues Alert Bulletins and For Your Information Notices (FYIs).
   - *Callback* is a monthly safety bulletin directed toward pilots, flight crews, air traffic controllers, and others directly involved in aircraft

operations. *Callback*'s content consists of representative de-identified incident report excerpts received in that month, articles on specialised subjects, and summaries of Alert messages and report intake. In recent years, it also covers ASRS research studies and issues relevant to the overall aviation community.

- *Directline* is produced by the ASRS technical staff and is designed to incorporate the analysts' perspectives. It makes extensive use of ASRS report narratives and analytical expertise. It is directed toward chief pilots, ATC facility managers, training officers, other aviation professionals, and public officials.
- Alert Bulletins are issued to individuals in a position of authority, such as FAA officials and airport mangers. The main purpose is to alert them to potential safety problems, so that they can investigate allegations and take corrective actions. A For Your Information Notice is a single-page bulletin used for less severe safety problems or when information is fragmentary[28].

2. Additionally, ASRS receives requests for computer searches of the database.

- ASRS data are provided without charge to individuals and organisations that make request information on safety issues.
- In addition to routine requests for database searches, ASRS also provides Quick Response database searches and analyses. A quick response report is created as their request to produce an analysis about particular safety issues, an identification of the main themes, and an inventory of recurring problems.

#### 6.5.1.4 The limitations of ASRS

From ASRS productive publications, it is apparent that ASRS has contributed to aviation safety through education and communication between the aviation community and the regulatory authority. However, it is not without problems. Some of its problems stem from the confidentiality and immunity granted to the reporter, and others are related to the use of ASRS data.

*Side effect of confidentiality* The de-identification of incidents discussed above makes it difficult to address many of the mechanics' safety concerns, since often these concerns are related to a specific aircraft make and model.

[28] A biweekly telephone conference, known as telecons, is held for ASRS staff to discuss potential safety concerns to FAA staff. Safety topics raised in Alerts or FYIs may be covered during telecons.

*Deficiency of immunity* Although provision of immunity may attract reporting, sometimes it results in huge numbers of the incident reports for events that can be detected by a monitoring system. The altitude deviation described above is a good example of this kind of problem.

*Misuse of ASRS data* As reports are submitted voluntarily and are subject to self-reporting biases, great care should be taken to ensure that the use of ASRS data will not present problems in comparative or statistical processes. The reports only represent the perception of specific individuals rather than the prevalence of problems within the aviation system. In addition, it is impossible to verify information after it has been de-identified. However, the US Freedom of Information Act enables the public to obtain a copy of the ASRS database, which not only results in the loss of confidence from reporters but may lead to misrepresentation of the data by careless recipients.

### 6.5.2 UK Incident Reporting Systems

#### 6.5.2.1 UK Mandatory Occurrence Reporting (MOR) Scheme

It is mandatory for most United Kingdom Public Transport Operations to report hazardous occurrences. Hazardous occurrences refer to any fault, problem or shortcoming of parts or people. The term "Occurrence" as used in the MOR Scheme includes both accidents and incidents. The Occurrence Reporting System is managed by Britain's Civil Aviation Authority (CAA) Research and Analysis Department (R&AD), which evaluates, investigates, progresses, disseminates, stores and analyses occurrence report data. When a report received is considered as an accident, it will be passed to the Air Accidents Investigation Branch (AAIB).

A reportable occurrence is defined in the Civil Air Publication (CAP) 382, the information and guidance document of MOR Scheme, as:

1. An incident relating to such an aircraft or any defect in or malfunctioning of, such an aircraft or any part or equipment of such an aircraft, being an incident, malfunctioning or defect endangering, of which if not corrected would endanger, the aircraft, its occupants or any other person;
2. Any defect in or malfunctioning of any facility on the ground used or intended to be used for purposes of, or in connection with the operation of such an aircraft, being a defect or malfunctioning endangering, or which if not corrected would endanger, an aircraft or its occupants.

It is obvious that the focus of the MOR Scheme is much broader than that of the US mandatory incident reporting requirements.

#### 6.5.2.2 UK Confidential Human-factors Incident Reporting Programme (CHIRP)

After reviewing the operation of its MOR Scheme, UK's CAA decided to set up a confidential human factors incident reporting scheme in order to complement MOR's lack of human factors information. Based on the ASRS system operating in the United States, Britain's CAA introduced a Confidential Human-factors Incident Reporting Programme (CHIRP) in December 1982, operated independently of the

CAA by the RAF Institute of Aviation Medicine (IAM). At first, CHIRP was designed to elicit human factors incidents[29] from the flight crew. Since 1986, the target population has been extended to the air traffic controllers[30] licensed by the CAA.

The number of reports varies greatly. Since the programme started in 1982, CHIRP has received 1900 flight deck reports. At the beginning, it received an average of 350 reports per year. Over the last five years the figure has been approximately 100-150 reports per year. Since 1986, approximately 400 Air Traffic Controller Reports have been received at a rate in the order of 25-30 per year (Tait, 1996).

CHIRP gives the reporter guarantees of confidentiality and immunity under the legal system as does ASRS. In order to have more information and clarify possible obscure points, the reporter has to give his identity on a tear-off section of the reporting form. Once the report is closed, the tear-off section will be removed and returned with an acknowledgement. RAF IAM guarantees that no record of the name and address will be kept in the computer database. The guarantee of complete anonymity makes the use of immunity from prosecution almost unnecessary. Additionally, the Data Protection Act in the UK does not require registration or unrestricted access to the data in the CHIRP database where names and addresses are excluded. As a result, the overt use of transactional immunity by reporters caused by the Freedom of Information Act in the USA is unlikely to occur in the UK. Nevertheless, the agreement of immunity indicates that the CAA will not take legal action against an infringement of the Air Navigation Order and Regulations, provided (CAA AIC 141/1992):

- The infringement was neither wilful nor grossly negligent;

[29] For flight crew a human factor incident is defined as an incident where:
a) A crew member's action or omission caused, or could have caused, a potentially hazardous situation, or
b) the operating environment, i.e. aircraft equipment or operating procedures, could have contributed to an error by a crew member.

[30] In the context of Air Traffic Control, a human factor incident is defined as an incident where:
a) An Air Traffic Controller's action or omission caused, or could have caused, a potentially hazardous situation; or
b) the operating environment could have contributed to an error by the controller.

- the person involved forwarded a completed confidential report from within ten days of the incident concerned;
- the infringement was directly connected with the human factor incident reported.

The procedures for processing the reports are identical to those used by ASRS, except the response time. The time taken to respond to each report varies based on the number of reports arriving, the complexity of the problem and the response of the agency involved with the situation. In a number of cases reporters make initial contact with CHIRP by telephone, and a follow-up written report follows. Only in a small percentage of cases are reporters unwilling to submit a written report (Tait, op. cit.).

From the data collected, CHIRP produces a three-time-a-year newsletter report entitled *Feedback* that, like the ASRS *Callback*, reports de-identified and most recent examples of recent incidents to its target population.

During the first ten years, CHIRP had been successful in improving cockpit lighting, changing the checklist to ensure pitot heat selected, modifying fuel switches to prevent errors in selection, alerting crews to navigational equipment inadequacies, and modifying software on ATC radar console (Wilson, 1992).

With the recent organisational changes within CHIRP, the expansion of the programme to include other groups within the aviation industry is being actively considered (Tait, op. cit.).

### 6.5.3 Canadian Confidential Aviation Safety Reporting Programme(CASRP)

The CASRP was established in 1985 by the Canadian Aviation Safety Board (CASB) under the recommendation of Mr. Justice Dubin in his *Report of the Commission of Inquiry on Aviation Safety.*

Fundamentally, CASRP is based on the US ASRS and UK CHIRP models. The marked difference to both ASRS and CHIRP is in the nature of the receiving agency. Unlike ASRS and CHIRP, CASRP is operated by CASB, the mandatory incident receiving agency and the investigation authority.

CASB adopted the same type of identification strip procedure used by ASRS and CHIRP to guarantee the confidentiality of reporter identity. Moreover, it ensured that the reporter was protected by the legislation, which stated (CTSB, 1988):

> *"The Canadian Aviation Safety Board Act prohibits any report made under this system from being used against the reporter in any legal or other proceedings. Also, no one can be required to give evidence in legal, disciplinary or other proceedings that could reasonably be expected to reveal the identity of any person making a report under this system."*

The same immunity was offered as in ASRS, but exemption of the system from the Canadian freedom of information act avoided many of the problems. No other immunity from regulatory, punitive, or disciplinary action was offered. The procedures for processing and storing the reports were similar to those used by ASRS, except that data structure and key word coding were fully compatible with ICAO's ADREP standards.

From 1985 to 1993, CASRP received 220 - 350 reports per year. Reports divide into 52% from pilots, 12% from flight attendants, 6% from passengers, 6% from ATC, and 24% from others. In order to promote greater awareness of the Programme and stimulate the quantity and quality of reports, various promotional efforts were undertaken. CASRP analysts visited the aviation community, such as flying schools, and air carriers, to correct misunderstandings and promote the Programme; CASRP was advertised in major aviation magazines to describe its aims and benefits; the feedback publications, *INSIGHT* and *Air Safety REFLEXIONS*, were distributed throughout the aviation community; a collect call telephone number with an answering machine was set up to encourage those people unwilling to report on paper.

In 1990, the CASB was replaced by the multi-model Canadian Transportation Accident Investigation and Safety Board (CTAISB). Another reform occurred in early 1996, when CTAISB was taken over by the Transportation Safety Board of Canada (TSB) and CASRP evolved into SECURITAS. SECURITAS is a multi-modal confidential reporting system for marine, rail, air and pipeline transportation modes. The major difference with the original CASRP is that there is no systematic call-back for reporters and no exclusive personnel to answer calls. Reporters leave messages on the answering machine, send Faxes, write or send E-mail on the Internet. However, the most popular way of reporting remains the phone message (Feminier, 1996).

Since the SECURITAS has used the Internet as a mode of reporting for such a short period, it is difficult to obtain any significant statistics regarding its effect on the collection of safety information (Feminier, op. cit.). Nevertheless, several lessons can be learned from the process of establishing a confidential reporting programme in Canada.

*Continuous promotion* CASRP received 485 confidential reports during the first year, but less than 50% (234) of them were considered to be of value. Finding that the promotion campaign prior to the introduction of the CASRP was incomplete, the CASB tried every way to increase the aviation community's awareness of the CASRP. More changes were made to overcome the problems discovered during the operation. Notwithstanding the growing pains, these promotional efforts show wide acceptance of the Programme by the Canadian aviation community.

*Consistent improvement* SECURITAS is the first multi-model confidential reporting programme to receive voluntary reports on safety concerns. In order to stimulate voluntary reports, various reporting methods are utilised. Reports can be submitted by mail, fax, telephone, or even e-mail. Moreover, the occurrence reports published by TSB since January 1995 can also be retrieved through its Internet site.

### 6.5.4 Australian Confidential Aviation Incident Reporting (CAIR)

In 1984, the Bureau of Air Safety Investigation (BASI) initiated a feasibility study for introducing a confidential reporting system, which included examination of confidential reporting programmes in operation in the world and elicitation of attitudes, opinions and recommendations from the industry. The study showed that the Australian aviation community strongly supported the introduction of a voluntary confidential incident reporting system to complement the mandatory incident reporting system (BASI, 1988).

Following the feasibility study, the CAIR programme was established in July 1988 and has been operated by BASI since then. BASI is the agency of the Australian Government which is responsible for the investigation of accidents and incidents occurring to civil aircraft in Australia and its territories. It is the legal recipient of air safety incident reports both mandatory and confidential. Air Safety Incident Reporting (ASIR) system deals with mandatory incident reports; CAIR system provides access to confidential incident reports. CAIR complements ASIR by eliciting reports from those people not prepared to use the mandatory ASIR, and by providing a facility for passing safety information which was previously unavailable to BASI. The main purposes are to utilise the information received to identify deficiencies that might adversely affect air safety, and thus to allow BASI to take action to prevent further accidents and incidents.

Australia employs an intentionally broad definition of an incident. An incident is defined as any occurrence, other than an accident, that affects or could affect the safety or operations of the aircraft. It is obligatory for anyone in the aviation industry to report all incidents considered undesirable or hazardous. Under the Australian Air Navigation Regulations, reports should be submitted to BASI within 48 hours of the event.

At first the CAIR programme was opened to flight crews only, and within a year of commencement, it became available to air traffic services officers, maintenance and ground-support personnel, flight attendants and any other person who has an aviation safety concern. The CAIR reporting forms are included in each issue of the Asia Pacific Air Safety (APAS), and available at aviation organisations throughout Australia. Telephone reports are also accepted, but written reports are preferred. CAIR receives 320 - 590 reports per year. The number of reports in Australia are second only to the system in the United States. 66% of the reports are from flight crew, mainly pilots, 18% from air traffic services officers, 10% from flight attendants, which includes some from passengers, and 6% from maintenance personnel (Nadal, 1995).

The formation and structure of CAIR is similar to other established programmes in the UK and Canada. Confidentiality is guaranteed by removing the reporter identity and by destroying the original report within three working days. Selected de-identified reports are published in APAS and circulated to the aviation industry and government bodies world-wide, thus providing the essential feedback component of the CAIR programme and informing readers of factors contributing to accidents and incidents investigated by the BASI.

Unlike the US ASRS system, BASI does not guarantee immunity from prosecution. It is believed the rapid process of de-identification and the guarantee of confidentiality ensure that prosecution action based on information provided to CAIR is not possible. The findings of evaluation also show that legislative backing to CAIR received little support from those interviewed, because they thought that such legislation might undermine the guarantee of confidentiality (BASI, 1993).

The situation of Australian CAIR provides several useful perspectives:

*Wide dissemination of information* During the course of the CAIR evaluation, a decline in reporting for the year July 1990 to June 1991 attracted BASI's attention. It concluded that at that time fewer briefings on the CAIR programme were made and the BASI Journal was not published. Thus, continuing education on such a reporting system and increased feedback to reporters became two major concerns for future developments. More discussion on education is canvassed in the next paragraph. With regard to the feedback, it is suggested that methods of feedback additional to the feedback publications should be investigated, which includes expanding section in the original publication and issuing a separate publication.

*Ongoing promotion* The report of evaluation of the CAIR Programme found out that most respondents claimed that they had a good understanding of the CAIR programme. However, their request in the questionnaire responses for further education through APAS, briefings and other forms (such as audio-visual and advertising) indicated otherwise. Therefore, constant reinforcement of a confidential incident reporting system needs to be addressed, including why the information is required, how the reports will be handled, and what will be done with the information. Apart from constant reinforcement to all members of the aviation community, there is a need to prepare specific education programs for those who do not understand the confidential reporting system. In Australia, specific education programs are particularly recommended for maintenance engineers and flight attendants since in the survey both these areas indicated relatively low understanding of the CAIR programme.

As some of the respondents in the survey believed that their report had little or no effect, immediate action should also be taken to encourage more reports to such an incident reporting system. Moreover, the reporting forms should be simplified to prevent a reluctance to fill out the form in detail.

It can be seen that such an ongoing promotion is critical to the effectiveness of a confidential incident reporting system.

*Maintenance of good contacts with the industry* In order to provide a reporting system's personnel with current knowledge of the aviation industry and expertise in advertising, educational methods and communication, an industry based advisory group is required for a confidential reporting system. The reason is that such an industry based advisory group is used by the US (ASRS), UK (CHIRP), Australia (CAIR) and Canadian confidential reporting systems, and proved to provide on-going assistance to these systems.

### 6.5.5 New Zealand's confidential aviation incident reporting systems

New Zealand has had two confidential aviation incident reporting systems, both of which have collapsed after failing to function properly.

The first confidential incident reporting system was floated in the mid 1980's by the "Aviation Safety Board", and an ad hoc committee set up to advise Colin McLauglin, then the Minister of Transport. It ended after a year or so because hardly any one reported to it. The second was established in 1990 and was called the Independent Safety Assurance Team (ISAT). It published received reports in *Flashback.* ISAT stopped in 1993. It was subject to the Airways Corporation, which was a state owned enterprise and controlled the Air Traffic System in New Zealand.

Referring to the author's correspondence with Mr. Russell Taylor, the President of Aircraft Owners' and Pilots' Association Incorporated, as well as New Zealand's CAA officials, the failure of these two systems was probably due to the incredibility of the receiving agencies in the eyes of the members of the aviation community. Taylor (1995) clearly states the problem: "Any organisation running a confidential system must be and be publicly perceived to be impartial, independent and competent, or a knowledgeable industry reporter will not use it. This seems to have been the failing with both of the above." Additionally, there was little support from the CAA and management in airlines. The small populations also resulted in the difficulty of ensuring the confidentiality of stored data. A pilot who had submitted a report was identified by the regulatory authority, and the event contributed to the close of the reporting system.

Notwithstanding the unsuccessful experience, the establishment of a third confidential reporting system is being actively considered.

### 6.5.6 European Confidential Aviation Safety Reporting Network (EUCARE)

The European Commission released its "Communication on Community initiatives concerning civil aviation incident and accidents" in September 1991 with the intention to improve accident prevention in Europe. The initiatives were launched in three areas: accident investigation, mandatory occurrence reports and confidential reporting systems. In the area of accident investigation, six principles governing the investigation of civil aviation accidents and incidents were established[31], the inclusion of which means that serious incidents will be treated in a similar way as accidents in terms of investigation and analysis. In the area of mandatory incident reporting, the definition and treatment of occurrences vary widely from one European State to another, so that the way incidents are dealt with needs to be levelled first in order to put together the relevant safety information derived from the collection of incompatible occurrence reporting systems from various Member States. Besides, most of the mandatory incident reports only show a portion of the operational problems, mainly the problems related to technical defects, and seldom human-factor incidents are seldom reported to such a scheme. Therefore, the confidential incident reporting system is needed to elicit more information in this area.

After surveying ASRS, CASRP and CHIRP, the European Commission found that no existing system would be suitable for such a multinational, multilingual and multicultural system. However, the European system is expected to co-operate closely with other national reporting systems in operation and integrate their experience and expertise wherever possible. Additionally, it is expected to be

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[31] The six fundamental principles are as follows: (Henrotte, 1995)

- the mandatory investigation of each accident and serious incident with the only objective to prevent its recurrence
- a clear separation between the judicial enquiry and the technical investigation with the reinforcement of the latter's statute
- the conduct of the investigation by a permanent and independent body
- the publication of an investigation report containing conclusions and eventual safety recommendations
- a system of follow up of these recommendations and
- the protection of the investigation against its use for purposes other than accident prevention.

compatible with a revised ICAO ADREP format, and allow co-ordination internationally with accident investigation boards and safety research organisations.

In 1992, the German Department of Transport funded a feasibility study that was ordered by the Commission of the European Communities to study the possibility of setting up a confidential reporting system in Germany. In the following year, EUCARE was established as a prototype of the future European system at the Technical University of Berlin. Financing and support are provided by the European Community and the Senat of Berlin.

EUCARE was introduced to the public by mailing about 18,000 information brochures containing a reporting form and a letter of recommendation by the Department of Transport. In the beginning, the fact that several airlines have their own reporting systems was significant. The airlines did not encourage their pilots to report internal safety problems to a system independent from their company. Thus, more than 80% of the reports involved General Aviation (Nieder, 1995). But as the early work proved that neither airlines nor pilots need to fear exposure after reporting to EUCARE, the number of reports from airline pilots has begun to rise steadily. Some airlines have even offered co-operation. At present EUCARE has not been extended to a European Community wide scheme, but reports have been received also from Switzerland, Belgium, the Netherlands and Denmark.

Not only any members of the aviation community, but also passengers can report to EUCARE any kind of information concerned with safety issues, so as not to rule out any information that might prove to be important. In 1995, more than half of the reports were submitted by pilots. 17% were contributed by ATC officers and 12% by engineers (Henrotte, 1995). Reporting can be made in a personal conversation, in writing or by telephone through a toll-free number.

The incoming reports are analysed in two phases by experts from all fields of aviation. Samples of the reports are published in "EUCAREVIEW", EUCARE's feedback magazine, after de-identification. Results from scientific research and analysis of topical safety hazards are also produced.

As the ultimate purpose of setting up EUCARE is to extend to a European scope, the problems that might need to be faced are:

*Difference of languages* Although single language reports seem more practical in processing data and cutting costs, many reporters might fear having to report in English. They might also not be able to describe the incident in English as well as in their native language. Apart from reporting, the dissemination of information can be better scrutinised and adopted in their own language.

*Geographical extent of operation* The geographical area of operation should be sufficiently large so that stored data would not be identifiable. On the other hand, the area should be sufficiently small that reporters can report by phone in their own language, and that the system's analysts are able to react immediately to the reported events (Green, op. cit.). Therefore, the boundary of each receiving agency should be carefully marked first.

### 6.5.7 Summary

It can be seen that the reporting systems currently in operation vary in a number of significant respects. The target populations differ, in that some are aimed at pilots and air traffic controllers, whereas others are promoted throughout the whole aviation community as well as people with a less direct involvement in aviation, such as passengers. The operating agencies differ. Some are operated by an independent agency; others are operated by the agency that also administer the mandatory reporting system and the investigation unit. Table 6.1 summarises the confidential reporting systems presently in existence, and Table 6.2 illustrates the percentage distributions of reporting sources.

## Table 6.1 The Existing Confidential Aviation Reporting Systems

| Name of system | Country | Year commenced | No. of reports each year | *Target population | Receiving agency | Routine publication |
|---|---|---|---|---|---|---|
| ASRS<br>The Aviation Safety Reporting System | USA | 1976 | 13,600 -34,300 | ①②③④⑤ | The National Aeronautics and Space Administration (NASA) | Callback, Directline |
| CHIRP<br>The Confidential Human-factor Incident Reporting Programme | UK | 1982 | 100 - 350 | ①② | The RAF Institute of Aviation Medicine | Feedback |
| SECURITAS | Canada | 1985 | 220 - 350 | ①②③④⑤ | The Transportation Safety Board of Canada (TSB) | Insight, Air Safety Reflexions |
| CAIR<br>The Confidential Aviation Incident Reporting Programme | Australia | 1988 | 320 - 590 | ①②③④⑤ | Bureau of Air Safety Investigation (BASI) | Asia Pacific Air Safety (APAS) |
| EUCARE | Germany | 1992 | n. a. | ①②③④ | Technical University of Berlin | EUCAREVIEW |

* Target population: ① Pilots ② Air Traffic Controllers ③ Flight attendant ④ Maintenance staff ⑤ Others involved in aviation

**Table 6.2 Source of Reports**

| Name of system | Flight Crew | Air Traffic Controllers | Flight Attendants | Others |
|---|---|---|---|---|
| ASRS ( 1988-1994 ) | 95% | 4% | | 1% |
| CHIRP ( 1982-1995 ) | 78% | 22% | | |
| CASRP ( 1985-1993 ) | 52% | 6% | 12% | 30% |
| CAIR (1991-1992) | 66% | 18% | 10% | 6% |
| EUCARE (1995) | 71% | 17% | | 12% |

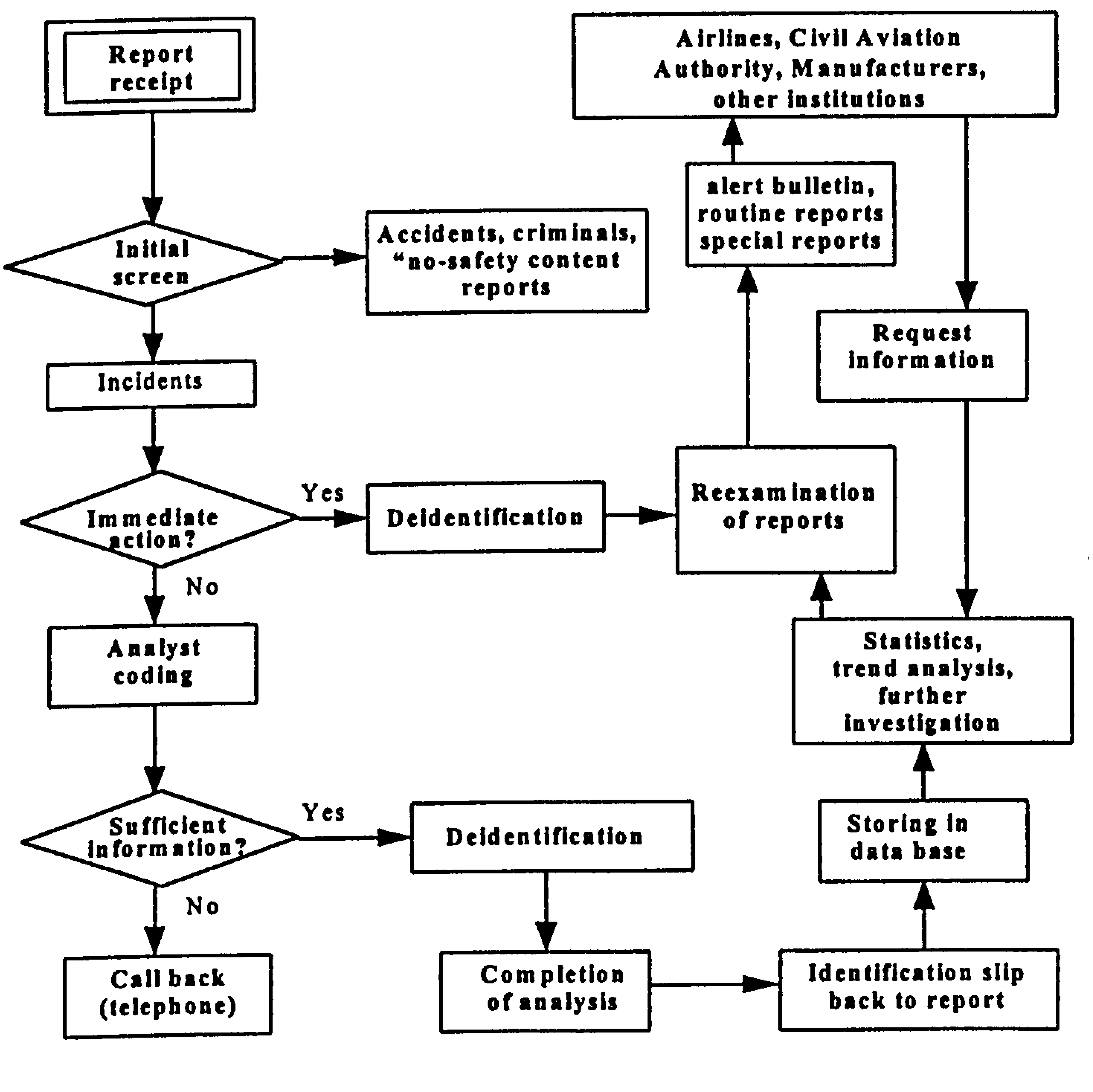


**Figure 6.2 The General Process of a Confidential Reporting Programme**

## 6.6 The philosophy of confidential incident reporting systems

Although all the confidential incident reporting systems currently in operation differ in detail, they share some fundamental characteristics. In order to explore the philosophy of confidential incident reporting systems, further discussion is presented below in terms of confidentiality, immunity, independence of the receiving agency, information feedback to the aviation community, and complement to mandatory reporting systems.

### 6.6.1 Confidentiality

The word 'confidential' is used to describe the procedures of de-identification. It is a guarantee that protects the reporter's identity from being known to any third party outside of the receiving agency, and that, once the details of the report are considered to be clear and complete, no record is kept of the report's identity. Moreover, any other information that could reveal the identification of the reporter will be removed before the report is made public, such as being published in the feedback magazine.

The time required for de-identification varies. The more rapid the process of de-identification is, the less likely the reporter's identity will be divulged. ASRS and CAIR attempts to clear all reports within three days. However, the broad focus of ASRS has indicated that three days is insufficient to respond to large numbers of reports arriving in a short interval. CASRP claims to clear reports within ten days. CHIRP and EUCARE do not specify a clearance time, but endeavour to clear the incoming reports as quickly as possible.

There is a great difference between an anonymous report and a confidential one. When a report is submitted anonymously, the report is unjustified and it is impossible to clarify obscure points in the report. Thus, most reporting systems do not accept anonymous reports.

Confidentiality has been described as the essential ingredient to determine the success or failure of a reporting system. Without it, there will be no credibility and therefore no confidence in the aviation community. As described in section 6.5.5, the difficulty of ensuring the confidentiality of stored data contributed to the demise of the reporting system in New Zealand in 1991.

### 6.6.2 Immunity

The term 'immunity' in this context refers to the guarantee for reporters of protection from punitive or disciplinary action by the aviation regulatory authorities, provided that criminal offences and accidents are not involved.

The promise of immunity is dependent on the extent of the system. In general, the broader the focus of a system is, the more likely it is that incidents reported to the confidential system will also be reported to the regulatory authorities via some other source. ASRS is heavily dependent on FAA promises of immunity, as approximately 25% of the incident reports received are also reported by some other source to the regulatory authorities (BASI, 1988). The impact of the US Freedom of Information Act makes it more difficult for ASRS to restrict access to the ASRS database. As a result, waiving immunity seems impossible and will decrease the number of reports substantially. CHIRP provides the same immunity to reporters as ASRS does; however, due to its narrower definition of an acceptable incident, no reports of incidents are also reported to the regulatory authorities. Thus, the regulatory promise of immunity is seldom put to the test. No immunity is offered under Canadian, New Zealand, Australian and German programmes. It is believed that the guarantee of complete confidentiality and the prevention of any access to their recorded information make the use of immunity measures unnecessary.

In Australia, despite little support for a legislative backing to CAIR, its evaluation report recommends that the provision of statutory privilege to responses to indemnify the responding organisation from defamation charges should be considered (BASI, 1993). It was also indicated that legislative protection may encourage more written responses to CAIR reports for publication and thus enhance the perception of the effectiveness of the CAIR program.

As ICAO Council President Dr. Assad Kotaite told safety experts at an ICAO divisional meeting in 1992, "Experience shows that in spite of the implementation of strong regulatory programmes many preventable accidents continue to occur. The limitations of regulatory safety measures are widely recognised. It is not surprising that a number of States have placed increased emphasis on non-punitive accident prevention activities to complement their regulatory safety programmes. It is, therefore, essential to incorporate additional non-regulatory accident prevention measures if we are to continue to improve aviation safety."

### 6.6.3 The receiving agency

ASRS was initially operated by the FAA. In spite of the guarantee of immunity and confidentiality, it soon became obvious that the aviation community did not have faith in the FAA. Being perceived as the law maker and enforcer of aviation regulations, the FAA did not earn the confidence and the credibility of the aviation community. It was therefore decided that to be successful, such a confidential reporting programme should be independent from the aviation regulatory authorities and be operated by a neutral third party. The importance of independence from the regulatory authorities was demonstrated again in New Zealand, where two confidential systems failed successively because of no credibility in the eyes of the members of the aviation community. Table 6.3 summarises the nature of these receiving agencies. All of them are independent from the aviation regulatory authorities.

**Table 6.3 The Nature of the Receiving Agency**

| System | ASRS | CHIRP | SECURITAS | CAIR | EUCARE |
|---|---|---|---|---|---|
| Operator | NASA | RAF IAM | TSB | BASI | TUB |
| Aviation regulatory authority | | | | | |
| Investigation agency | | | ✓ | ✓ | |
| The receiving agency of the mandatory system | | | ✓ | ✓ | |
| The receiving agency of the confidential system | ✓ | ✓ | | | ✓ |

Apart from the concept of independence from the aviation regulatory authorities, a suitable receiving agency should be able to:

- guarantee confidentiality of reporter identity;
- access reports from all sections of aviation;
- maintain a centralised and standardised database for all occurrence information, and achieve compatibility with data reported via the mandatory system;
- use the information gained to directly influence aviation safety;
- disperse the operational costs;
- funded on an independent basis.

One of the important functions of current confidential incident reporting systems is to directly influence aviation safety by providing the aviation industry and research organisations with informative data, publications and research findings. Even though these confidential incident reporting systems do not have formal authority to direct corrective actions, their valuable research reports and publications appear to contribute to the prevention of aviation accidents.

In order to protect individual reporters, the receiving agency should be independent from the aviation regulatory authorities. Whereas a total independence of the receiving agency is of necessity to protect itself and its system, the source of funding and immunity promise for a confidential system, for example, is likely to influence its operational decisions.

The earlier established ASRS and CHIRP systems are dependent on the FAA and CAA for both the promise of immunity and funding. Both aviation regulatory authorities have at one time or another threatened to withdraw support from the respective confidential reporting systems. For this reason, the Canadian CASRP, Australian CAIR and German EUCARE carry no promise of immunity and are funded independently from the aviation regulatory authorities. Therefore, they are unlikely to be threatened by withdrawal of support, and this ensures the neutrality of the system.

### 6.6.4 Information feedback to the aviation community

The basic purpose of setting up a confidential reporting system is experience and information sharing. An information feedback mechanism to the aviation community ensures the success of a confidential reporting system. Regular feedback provides aviation community with a valuable source of information on human operator errors. The two main functions of information feedback are to:

1. Notify the aviation regulatory authorities, organisations, aircraft manufacturers, and airlines concerned about identified hazardous conditions and unsafe practices.
2. Undertake topical research studies in order to understand possible causes of an incident, define intervention strategies, and track their consequences

There are many ways of disseminating information:

- newsletter
- alert bulletins
- special reports
- requests from institutions, organisations, authorities
- database research
- scientific research
- lectures
- press release

Through the various levels of feedback, the members of the aviation community are able to benefit from the information stored in the database. For example, information feedback may serve as reference for the aviation regulatory authorities when amending safety regulations. Such information is important to manufacturers in designing or modifying aircraft. Airlines may also use the information in promoting better training and enhancing safety awareness. In other words, it provides operators with a channel to reflect their problems to the aviation regulatory authorities, aircraft manufacturers, and airlines. Moreover, it makes these reporters feel that their reports are taken care of and scrutinised, which not only encourages people to submit reports, but also advertises the existence of the system.

### 6.6.5 Complement to mandatory incident reporting system

The majority of mandatory systems require their members of the aviation community to report certain types of incidents. In order to ensure the enforcement of a mandatory incident reporting system, detailed regulations about who submits reports and what events get reported need to be specified. These regulations define a base level of hazards, below which an incident report is not required but reporting is suggested to report. However, aircraft operations vary from one aircraft model to another, and a minor occurrence may be transformed into a significant hazard or an accident under a specific situation. Thus, it is impossible to define precisely every significant hazard which requires reporting. In addition, the listed reportable occurrences mainly focus on technical failures rather than on the human performance aspects. To supplement mandatory systems, confidential incident reporting systems aiming specifically at collecting more information on the human factor aspects have been introduced in many countries and airlines.

In confidential systems, pilots, air traffic controllers and others involved in aviation are encouraged to report hazards, discrepancies or deficiencies in which they are involved or have observed. The mandatory requirements and the confidential systems are aimed predominantly at the same target group, but because of the guarantee of confidentiality and the independence of the receiving agency, confidential systems tend to be more successful than mandatory systems in acquiring human factor related information.

## 6.7 International exchange of safety data

The main purpose of collecting incident data to identify potential hazards in order to take effective remedial action. Although informaton may be diverse, a clear picture of a problem area is often exposed by examining the frequency of similar occurrences. In other words, the larger the numbers of similar incident reports are, the more likely they are to permit the identification of potential hazards. To expand the volume of database, international exchange of data from reporting systems is encouraged among some countries and safety organisations. Such international exchange of safety data is especially valuable to smaller countries or organisations whose database is too limited to examine and analyse trends, or who do not have incident reporting systems.

The effectiveness of data exchange depends heavily on the compatibility of existing data management systems. However, the reporting systems in operation revealed radically different data structures. A number of countries use electronic document management systems or compatible formats and codes for data storage and retrieval, like BASIS+ in use at USA ASRS. Other systems, such as Canada SECURITAS and Australia CAIR, use the ICAO ADREP coding schemes or its compatible codes for reporting and database analysis. Table 6.4 summarises the software systems in use at each national reporting system.

**Table 6.4 Software System in Use**

| Reporting System | Electronic Document Management System | Relational Database Management System |
|---|---|---|
| USA ASRS | BASIS, BASIS+ | |
| UK CAA | BASIS+ | |
| Canada SECURITAS | | ORACLE (ASIS II) |
| Australia CAIR | | ORACLE (ASIS II) |
| Germany EUCARE | an EDMS software | |

For the maximum effectiveness of using and circulating incident data, great effort should be provided to develop common coding system to meet the needs of all reporting systems, and thus benefit everyone with each other's experience.

As Negroponte (1995) indicates, the change from atoms to bits is irrevocable and unstoppable. Due to the prevalence of Internet, the utilisation of electronic services is increasing in the aviation community. Electronic mail and the Internet Safety Web not only enable the exchange of data, but also expedite the collection and the dissemination of safety information.

In an effort to encourage more reporting, electronic receipt of reports is being used or being considered for use by some reporting systems, like SECURITAS, EUCARE and ASRS. Electronic reporting is more than offering an alternative method of reporting. Basically, it costs less than the traditional mode of reporting. It also offers possibilities for automation of manual processes, such as saving time in submissions and processing. A carefully managed electronic reporting system may be used to exchange confidential information among various safety focal points, and to alert the whole aviation community to safety problems within a short period of time.

# CHAPTER 7

# TAIWANESE AVIATION COMMUNITY'S REACTION TO THE INTRODUCTION OF A CONFIDENTIAL REPORTING SYSTEM

" A uniform with four rings on the sleeve and 20,000 flying hours do not make us immune from those human limitations ."

-------- *Captain Paul Wilson*

## 7. Overview

The proposed philosophy for a Taiwanese confidential incident reporting system is to utilise the information received to identify deficiencies in facilities, equipment, regulation, instructions, or training that might adversely affect flight safety. In addition, the reports fulfil an important safety education function by enabling people to learn from the experience of others. Of particular importance are reports of systemic deficiencies which in particular combinations of circumstances lead to a failure of the system. The emphasis of the system is not on individuals, but on systems, procedures, and equipment. The reports will assist to identify unsound practices or facilities which might compromise safety.

In order to investigate the aviation community's reaction to the possible introduction of such a national-level confidential reporting system, a feasibility study was initiated. This chapter summarises the results of the postal questionnaire and interview surveys of the study. The first section describes study methods, and Section 2 presents biographical results of the subjects surveyed. Sections 3 through 9 discuss the differences between the airline pilots and the ATC controllers on issues concerning implementation of a confidential reporting system. In order to explore these issues, further discussion is offered at the end of each section.

## 7.1 Method: General overview

### 7.1.1 The chosen methodology

Airline pilots and ATC controllers were chosen as the target groups in the feasibility study, as they have accounted for the majority of reports filed with existing incident reporting systems.

Questionnaires and interviews are used in the study to achieve the understanding and viewpoint of the Taiwanese aviation community about establishing a national-level confidential incident reporting system. Interviews, in particular, are adopted to elicit information which cannot be obtained from self-completion questionnaires.

Consideration was also given to improving the response rate of self-completion questionnaires. The techniques employed in the questionnaire survey were as follows:

- The questionnaires for airline pilots and ATC controllers (see Appendix H and I ) were printed on coloured paper in order to make it appear more interesting;
- A covering letter was enclosed to inform the participants of the purpose and importance of the research, to assure confidentiality and to encourage a reply;
- A stamped addressed envelope for return of the questionnaire was enclosed;
- The draft of proposal leaflet of the Taiwanese confidential incident reporting system was enclosed; in addition,
- The author also enclosed two examples of CHIRP, ASRS reports (see Appendix ), a brief introduction of the confidential reporting systems in operation, and a translated research paper titled "Hurry Up Syndrome".

It is hoped that the use of both interviews and questionnaires as complementary approaches avoids the shortcomings of either, and strengthens the validity and reliability of the data obtained.

The survey in the study aims to:

- understand pilots and ATC controllers' attitude and experience of sharing safety information,

- ellicite pilots and ATC controllers' knowledge and understanding of the confidential incident reporting systems current in use worldwide,
- probe the possible reasons for pilots and ATC controllers for not reporting incidents,
- evaluate the extent to which the Taiwanese airline community might accept to a confidential reporting system,
- investigate opinions about the feasibility of a Taiwanese confidential incident reporting system, and
- understand pilots and ATC controllers' usage of personal computers and their opinions on sharing safety information via the Internet.

### 7.1.2 The design of the postal questionnaire

Considering the necessity for generating a series of items for inclusion in the survey, informal interviews were conducted with management pilots and flight safety managers to elicit information about the possible factors relevant to the undertaking of this study. The ideas for questionnaire design obtained from these meetings were later implemented in the final questionnaire.

A pilot test was then conducted in order to determine whether or not the questions and instructions were clear and readily understood. The sample subjects of the pilot test included 10 pilots who were training at the British Aerospace Flying Training Centre in Woodford, and 4 ATC controllers working at Taipei Approach Centre. The author was available to answer queries about the questionnaire and to observe and communicate with the sample subjects when they filled it in so that any possible misunderstanding of the questions could be avoided or corrected. This procedure and the respondents' comments led to minor modifications of some questions. One suggestion from respondents in the pilot study was to include the Airline Pilot Association (ALPA) as one of the selected receiving agencies.

The final questionnaire consisted of three parts: the first contained questions about the pilots' biographical details; the second, questions about the pilots' opinions and perception on the introduction of a confidential aviation incident reporting system; and the third part, questions about sharing safety information via the Internet.

Questions in the first part asked about the subjects' current position, number of years in the airline community, and source of initial training. The second part comprised fourteen questions addressing: subjects' willingness for sharing flying or safety experience, their cognition and expectation of incident reporting systems, the possible difficulties likely to be encountered in implementing such a reporting system in Taiwan, their possible reasons for not reporting, and their choice of the optimal receiving agency. At the end of this part respondents were given space for freehand comments. The third part had six questions and was designed to ascertain the extent of acceptance for using the Internet and E-mail in transferring aviation safety information

### 7.1.3 The interview questionnaire

For the purpose of this study a multi-method approach was considered appropriate for two reasons. Questionnaires help to examine the differences between respondents on a general basis, and interviews, as a complement to questionnaires, offer the freedom to discuss the situation with the respondents, and to raise specific queries concerning the setting up of a confidential aviation incident reporting system.

As shown in Appendix K, the interview questionnaire included only open questions and this part of the study was conducted after the postal questionnaire.

Interviews were also held with respondents in both pilot and ATC controller group. While the questionnaire formed the backbone of matters discussed, these interviews provided additional information on incident reporting issues. Much of the attached information would not have been provided if the respondents had been restricted to providing responses only by way of a questionnaire. Indeed many of their anecdotes and views give a level of nuance which might provide a more complete assessment of the perceptions held by the study subjects.

### 7.1.4 Sampling strategy and limitation

Negotiation for access is still a continuous and laborious process. As mentioned earlier, the study was taking place in conservative environment, and thus great difficulties were encountered in clearing official channels for permission to carry out the work. It took much time for the author to contact the managers and discuss the study with them in order to gain access. Although it was the second survey to have been undertaken, there still were unexpected problems. One of the domestic airlines completed the first survey about airline safety management, but broke the agreement to carry out the second survey for aviation incident reporting system. It was cancelled because the top management did not show approval or disapproval, which was interpreted as a sign of disapproval. Therefore, the samples of the pilots who participated in the study was from the remaining five airlines.

### 7.1.5 Distribution procedure

The questionnaire survey was taken or sent to the representative at each participating airline in sealed envelopes and distributed to the subjects by each organisation's administrator. Included with the questionnaire was a covering letter from the author, a memo from the senior manager of each organisation, and a postage paid addressed envelope. The covering letter explained the purpose of the research, ensured its confidentiality and anonymity of all responses. The pre-addressed stamped envelope enabled the direct return of the completed information to the author.

## 7.2 Biographical results

### 7.2.1 Response rate details

The study includes two major parts: postal questionnaire survey and interview survey. Of the 834 questionnaires distributed, 287 were completed and returned in time for analysis, representing a response rate of 34.4%. A detailed account of the response rates of the postal and interview surveys is given in Table 7.1.

**Table 7.1 Response Rates of the Postal and Interview Surveys**

| Administration of Survey | Subject | Sent | Received | Response Rate |
|---|---|---|---|---|
| Postal | Pilot study | N = 14 | n = 14 | 100.0% |
| | Airline pilot | N = 614 | n = 211 (218) | 35.5% |
| | ATC controller | N = 220 | n = 68 (69) | 30.9% |
| Interview | Pilot/Controller | N = 8 / 6 | n = 8 / 6 | 100.0% |

Under the "received" column, the numbers in parentheses are the actual returned copies of questionnaires, and the numbers without the parentheses represent the valid copies of questionnaires.

### 7.2.2 Respondents' working experience and personal details

A breakdown of the response according to the respondent's position is presented in Table 7.2. There were 99 Captains and 112 First Officers included in this study.

**Table 7. 2 Current Position of the Pilot Respondents**

| Position | Frequency | Percent |
|---|---|---|
| Captain | 99 | 46.9 % |
| First officer | 112 | 53.1 % |

n = 211

Chi-square goodness of fit analyses was performed to determine whether the distribution of responses according to position was significant for the pilot target population. The observed and expected frequencies for each cell are presented in table 7.3. The results indicated that the obtained chi-square was not significant at the 0.05 level. It can therefore be concluded that the distribution of respondent pilots between Captains and First Officers reflected the distribution of ranks in the population from which they were drawn.

**Table 7.3**
**One-way Chi-square to Examine the Distribution of Respondents According to Position: Observed and Expected Cell Frequencies**

| Captains | First Officers |
|---|---|
| Observed frequency = 99 | Observed frequency = 112 |
| Expected frequency = 105 | Expected frequency = 105 |

$p > .05$, $df = 1$, $X^2_{obt} = 0.801$

Analysis of the personal data for pilots (n = 211) revealed that the majority of these pilots had been working in civil aviation for 2-10 years, corresponding to 70.1% (see Table 7.4). The proportion ratio for the pilot group was almost the same as that in the previous study (see Table 4.5).

**Table 7.4 Working Experience in Airlines**

| Working Experience | Frequency | Percent |
|---|---|---|
| Less than 2 years | 30 | 14.2 % |
| 2 - 5 years | 82 | 38.8 % |
| 6 - 10 years | 66 | 31.3 % |
| 11 - 15 years | 18 | 8.6 % |
| More than 15 years | 15 | 7.1 % |

n = 211

Of the 211 pilot respondents, 158 had initial flying training in the military, 49 were given *Ab-initio* training, and 4 were trained in general aviation (see Table 7.5).

**Table 7. 5 Initial Flying Training Background of the Pilot Respondents**

| Background | Frequency | Percent |
|---|---|---|
| Military | 158 | 74.9 % |
| *Ab-initio* | 49 | 23.2 % |
| General aviation | 4 | 1.9 % |

n = 211

The distribution of responses of ATC controllers according to current position, working experience, and current service unit is presented in Tables 7.6, 7.7, and 7.8.

More than 40% of the ATC respondents had more than 10 year working experience in aviation. 18 (26.4%) worked at the control tower, 22 (32.4%) at the Area Control Centre, and 28 (41.2%) at the Approach Control Centre.

**Table 7. 6 Current Position of the ATC Respondents**

| Position | Frequency | Percent |
|---|---|---|
| Air traffic controller | 42 | 61.8 % |
| Assistant traffic controller | 12 | 17.6 % |
| Senior traffic controller or supervisor | 12 | 17.6 % |
| Other | 2 | 2.9 % |

n = 68

**Table 7. 7 Working Experience in ATC**

| Working Experience | Frequency | Percent |
|---|---|---|
| Less than 2 years | 4 | 5.9 % |
| 2 - 5 years | 13 | 19.1 % |
| 6 - 10 years | 23 | 33.8 % |
| 11 - 15 years | 16 | 23.5 % |
| More than 15 years | 12 | 17.6 % |

n = 68

**Table 7. 8 Current Service Unit of the ATC Respondents**

| Service Unit | Frequency | Percent |
|---|---|---|
| Control tower | 18 | 26.4 % |
| Area control | 22 | 32.4 % |
| Approach control | 28 | 41.2 % |

n = 68

## 7.3 About sharing information and experience

### 7.3.1 Results

The responses to the survey questions are summarised in the tables on the following pages. All of these tables contain entries for both the total numbers and the percentage of responses.

*Question 1:* *Are you willing to share your flying or safety experience with others?*

100% of the pilots (n = 211) and ATC controllers (n = 68) indicated that they were willing to share their flying or safety experience with others.

*Question 2:* *Do you encourage others to share their flying or safety experience?*

The responses to this question indicate that nearly all favoured the question, corresponding to 97.6% of the pilots and 97.1% of the ATC controllers. However, the rates are less than those in the previous question, which, as so they stated, results from the fear of penalty or bad consequence.

*Question 3:* *Have you ever voluntarily reported flight incidents or hazard events?*

Figure 7.1 depicts the distribution of respondents experience on voluntarily reporting incidents by their roles, i.e., airline pilots, and ATC controllers. The stack bar presents the number of respondents experience on voluntarily reporting incidents. The contrast between pilots and ATC controllers was significant ( $p < .001$, $df = 1$, $X^2_{obt} = 33.06$ ). It is apparent that the airline pilots have more experience of reporting incidents than the ATC controllers.

Among the pilot respondents, 85.3% of the Captains indicated that they had experienced on reporting incidents, whereas only 40.4% of the First Officers did so (see Table 7.9). It appears, therefore, that the Captains tend to experience more incident reporting than the First Officers, and the difference was significant at .001 level ($p<.001$, $df = 1$, $X^2_{obt} = 43.65$).

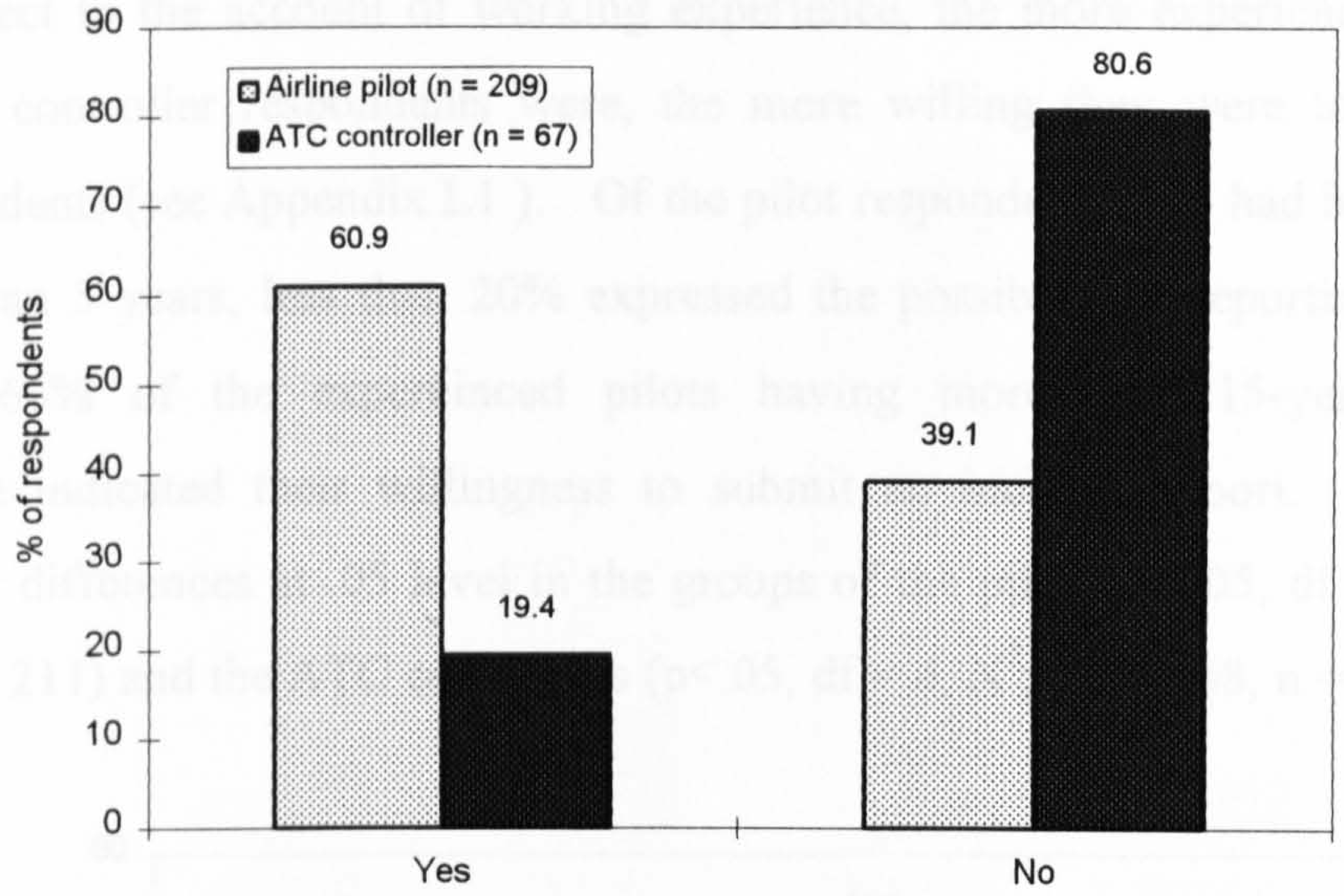


**Figure 7.1 Respondents Experience on Reporting Incidents**

**Table 7.9**
**Pilot Respondents Experience on Reporting Incidents**

| | Captain ( n = 95 ) | | First officer ( n = 114 ) | |
|---|---|---|---|---|
| | Frequency | Percent | Frequency | Percent |
| Yes | 81 | 85.3 % | 46 | 40.4 % |
| No | 14 | 14.7 % | 68 | 59.6 % |

Captain vs. First officer: $p < .001$, $df = 1$, $X^2_{obt} = 43.65$

*Question 4:* *Under the current situation in Taiwan, do you think it is possible for pilots to voluntarily share or report aviation incidents?*

Figure 7.2 illustrates the possibility for pilots and ATC controllers to voluntarily report human performance related incidents. The results show that ATC controllers were more likely to report human performance related incidents than airline pilots, and the contrast was significant at the .05 level ($p < .05$, $df = 1$, $X^2_{obt} = 33.06$, $n = 278$).

Subsequent analysis suggested that the Captains were more likely to file a report than the First Officers (see Figure 7.3). Chi-Square revealed that there were significant differences at the .001 level between the Captains and the First Officers ($p < .001$, $df = 1$, $X^2_{obt} = 11.36$, $n =211$).

With respect to the account of working experience, the more experienced the pilot and ATC controller respondents were, the more willing they were to voluntarily report incidents (see Appendix L1 ). Of the pilot respondents who had been working for less than 5 years, less than 20% expressed the possiblity of reporting incidents. Whereas 60% of the expereinced pilots having more than 15-years working experience indicated their willingness to submit an incident report. There were significant differences at .05 level in the groups of the pilots ($p<.05$, $df = 4$, $X^2_{obt} = 11.12$. $n = 211$) and the ATC controllers ($p<.05$, $df = 4$, $X^2_{obt} = 12.48$, $n = 67$).

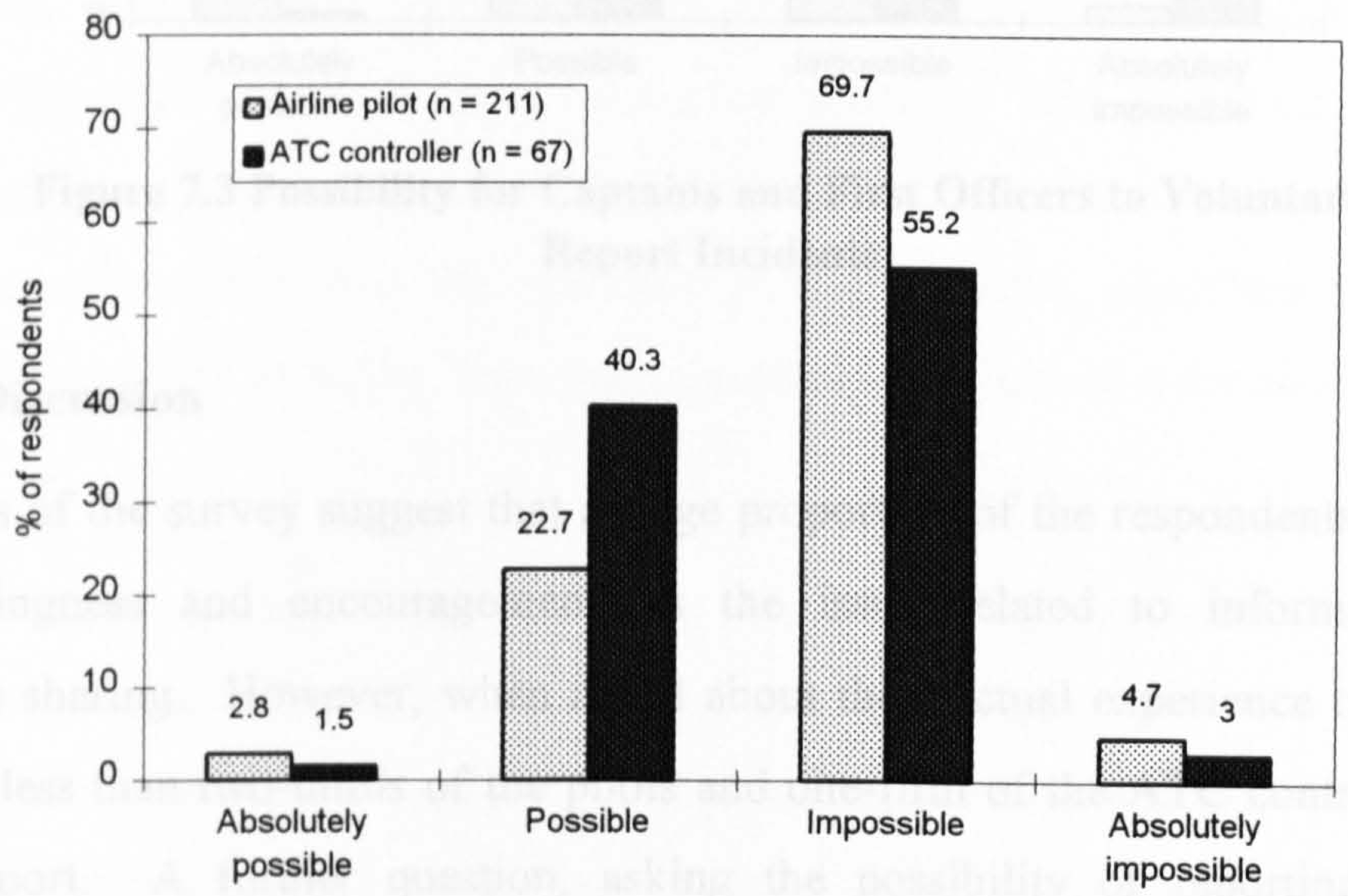


**Figure 7.2 Possibility for Pilots and Air Traffic Controllers to Voluntarily Report Incidents**

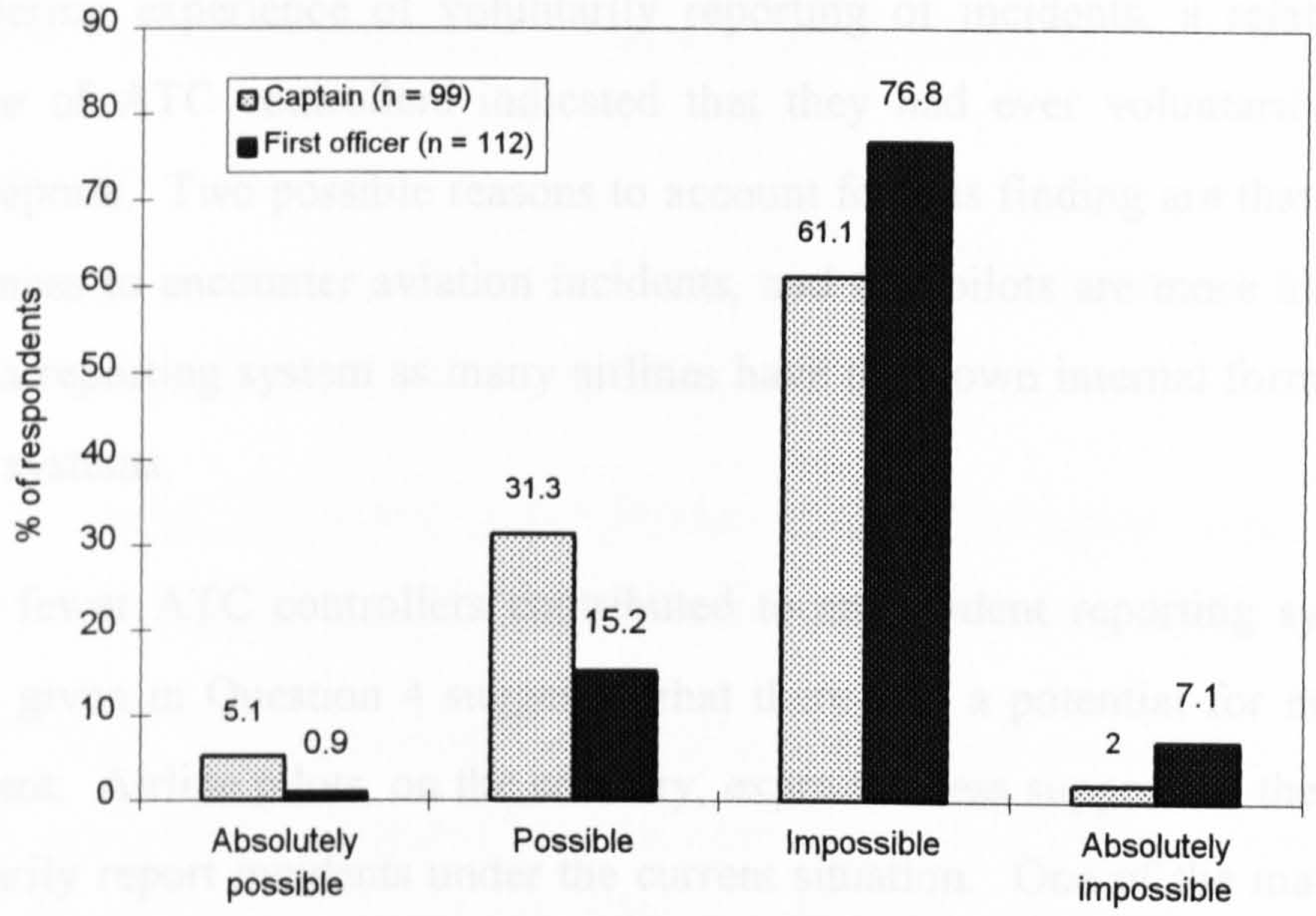


**Figure 7.3 Possibility for Captains and First Officers to Voluntarily Report Incidents**

### 7.3.2 Discussion

The results of the survey suggest that a large proportion of the respondents indicated their willingness and encouragement on the issue related to information and experience sharing. However, when asked about their actual experience of incident reporting, less than two-thirds of the pilots and one-fifth of the ATC controllers had filed a report. A further question, asking the possibility of reporting aviation incidents under the current situation in Taiwan, revealed that a relatively small percentage (25.5%) of the pilots gave positive answers. ATC controllers, on the contrary, showed stronger support (41.8%) for the possibility of voluntary reporting.

The first conflict in connection with the willingness to report incidents clearly lies with how ideals and beliefs are implemented in reality. According to the results, information and experience sharing is welcomed; but in practice, potential reporters hesitate to file an incident report. The discussion of Chapter 6 reveals that even when they report, most of the reports are related to technical problems rather than human performance error. It is, therefore, reasonable that less than 30% of the respondents thought it was possible to report aviation incident under the current situation.

In considering experience of voluntarily reporting of incidents, a relatively small percentage of ATC controllers indicated that they had ever voluntarily submitted incident reports. Two possible reasons to account for this finding are that pilots have more chances to encounter aviation incidents, and that pilots are more likely to gain access to a reporting system as many airlines have their own internal formal/informal reporting systems.

Although fewer ATC controllers contributed to an incident reporting system, their responses given in Question 4 suggested that there was a potential for much higher involvement. Airline pilots, on the contrary, expressed less support on the possibility to voluntarily report incidents under the current situation. One of the main conflicts would appear to arise from the nature of a punitive environment. Due to the fact that pilots are usually involved in the operation of hazard events, pilots are more likely than ATC controllers to suffer from bad consequences, such as suspension or losing their jobs.

A detailed analysis of the difference among pilot respondents revealed that the First Officers not only contributed less to incident reporting systems but also indicated a lower possibility for them to report. The findings reflect the phenomenon of vertical management in organisational structure. In most Asian societies, direct referral to sensitive issues is taboo. As a result, a First Officer is unlikely to challenge a Captain even if the captain makes a mistake.

## 7.4 About knowing and understanding other confidential reporting systems

### 7.4.1 Results

The following questions were intended to obtain the respondents' awareness of aviation incident reporting systems and their publications.

*Question 5:* *Have you heard of any foreign voluntary aviation incident reporting system, such as CHIRP in the UK or ASRS in the USA?*

Table 7.10 shows that approximately one-third of the pilots and one-fifth of the ATC controllers indicated that they had heard of other voluntary aviation incident reporting systems. There was no significant difference between the Captains and the First Officers on the issue.

**Table 7.10 The Knowledge of Any Foreign Voluntary Aviation Incident Reporting System**

| | Pilot ( n =211 ) | | ATC controllers( n = 67 ) | |
|---|---|---|---|---|
| | Frequency | Percent | Frequency | Percent |
| Yes | 69 | 32.8 % | 12 | 19.1 % |
| No | 142 | 67.2% | 55 | 80.9 % |

*Question 6:* *Have you ever read any research papers or reports from aviation incident reporting systems?*

*Question 7:* *If so, are these papers or reports written in Chinese or English?*

60 of the 69 pilot respondents who gave positive answers in the previous question indicated that they had read the research papers or reports from aviation incident reporting systems (see Table 7.11). Among them, 39.3% had read Chinese papers or reports[31], and the rest, 60.7%, had read their publications written in English.

Among 18.2% ATC respondents that were aware of foreign voluntary aviation incident reporting systems, 15.1% indicated that they had read these systems'

[31] Flight Safety Foundation - Taiwan has translated several research papers or reports from other aviation incident reporting systems, and published them in its Flight Safety Magazine.

publications (see Table 7.11). Most of the papers or reports they had read were written in Chinese.

**Table 7.11 Contact with the Research Papers or Reports from Aviation Incident Reporting Systems**

| | Pilot ( n =207 ) | | ATC controllers( n = 66 ) | |
|---|---|---|---|---|
| | Frequency | Percent | Frequency | Percent |
| Yes | 60 | 29.0 % | 10 | 15.1 % |
| No | 147 | 71.0 % | 56 | 84.9 % |

### 7.4.2 Discussion

The responses to the above questions indicated that foreign voluntary aviation incident reporting systems and their publications were not well known in the aviation community, with airline pilots being slightly more aware of them than ATC controllers.

Of course, the questionnaire itself may have reminded some respondents about the existence of these systems. Moreover, non-respondents to the present survey may have been expected to be less aware of these systems than the respondents. It is reasonable to presume that the awareness of these systems may be somewhat lower than was indicated by the survey response. Such low awareness only reflects the necessity of education and promotion.

Education and promotion have been the two prime concerns to existing confidential reporting systems. Before the implementation of a confidential reporting system, education of the target population and on-going promotion have proved to ensure the success of the system. Even after the establishment of the system, periodic promotion is needed to maintain interest and awareness.

Promotional efforts not only can increase system awareness, but also build confidence in the system, and make it easier for individuals to take part in the system. Promotional activities include:

- Distributing reporting forms, brochures, and display materials;
- Visiting the aviation community to increase mutual understanding;

- Publishing feedback magazines;
- Advertising;
- Getting involved in aviation associations;
- Simplifying the procedures for submitting reports;
- Improving the reporter's satisfaction.

## 7.5 About the potential receiving agency

### 7.5.1 Introduction

The receiving agency of a confidential reporting system is like a doctor or a priest, whom the reporter can trust to report incidents in which they were involved or which they had observed, and through whom their notification of such an incident can be beneficial to aviation safety. Due to the possible involvement of the reporter, confidentiality is required for such a system to protect the reporter from disciplinary action. As a consequence, the success of a confidential reporting system depends heavily on its independence from regulatory authorities.

Figure 7.4 illustrates an ideal receiving agency's relationship with the aviation community and regulatory authorities.

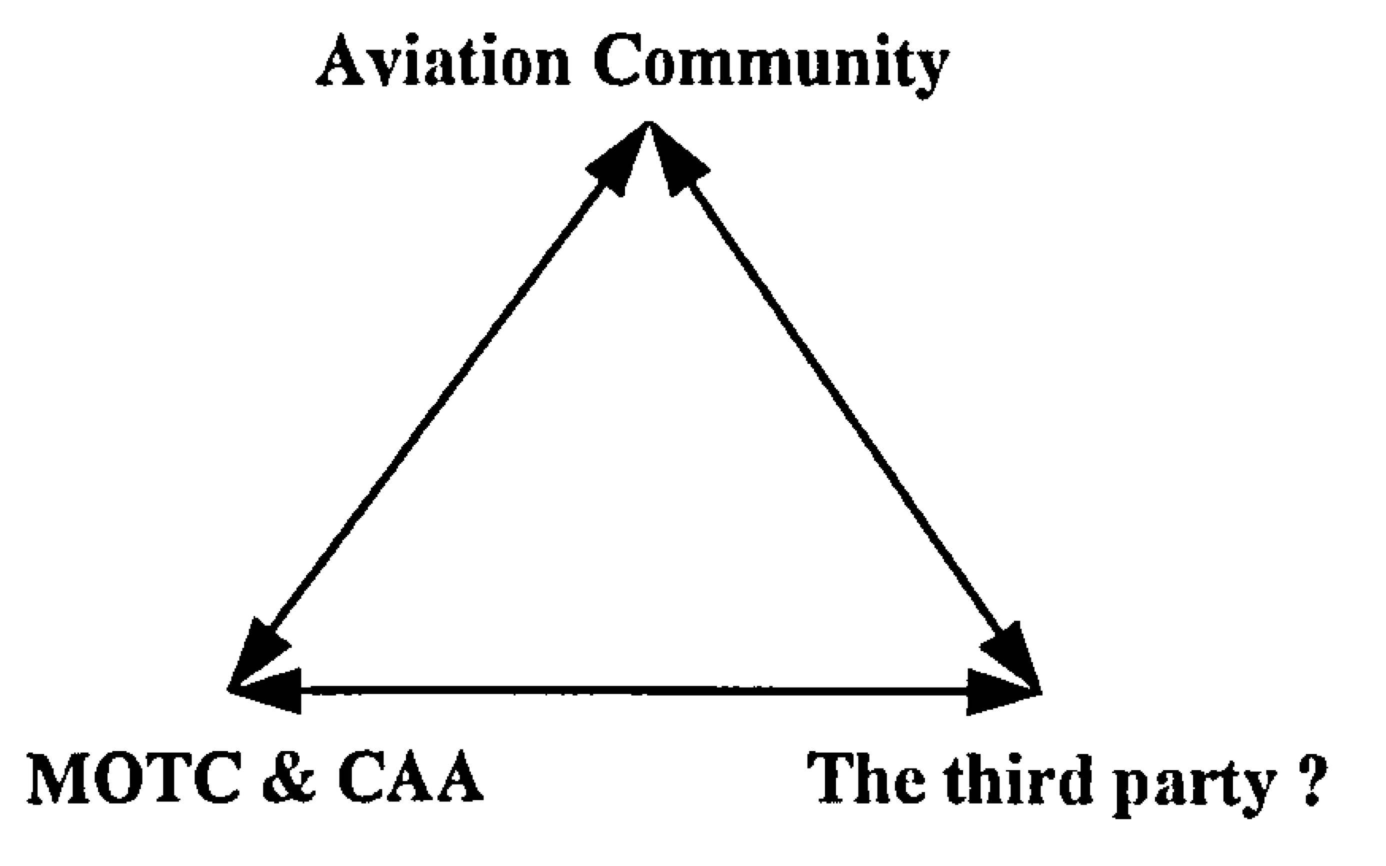


**Figure 7.4 Relationship among CAA, Aviation Community and the Ideal Receiving Agency**

### 7.5.2 Results

*Question 10:* *If the confidential reporting system is established in Taiwan, which do you think is the best agency to administer the system?*

When asked to choose the best receiving agency, more than 50% of the pilots and ATC controllers surveyed selected "research institute or school". About 40% of those surveyed chose "Flight Safety Foundation" as their ideal receiving agency. It is obvious that "Airline Pilot Association" received much more support from the airline pilots (44.5%) than from the ATC controllers (2.9%). The response to this question suggested that regulatory authorities, such as CAA-Taiwan and Ministry of Transportation and Communication (MOTC), were considered not suitable as the best agency in the eyes of most respondents. Figure 7.5 clearly presents the distribution of the responses.

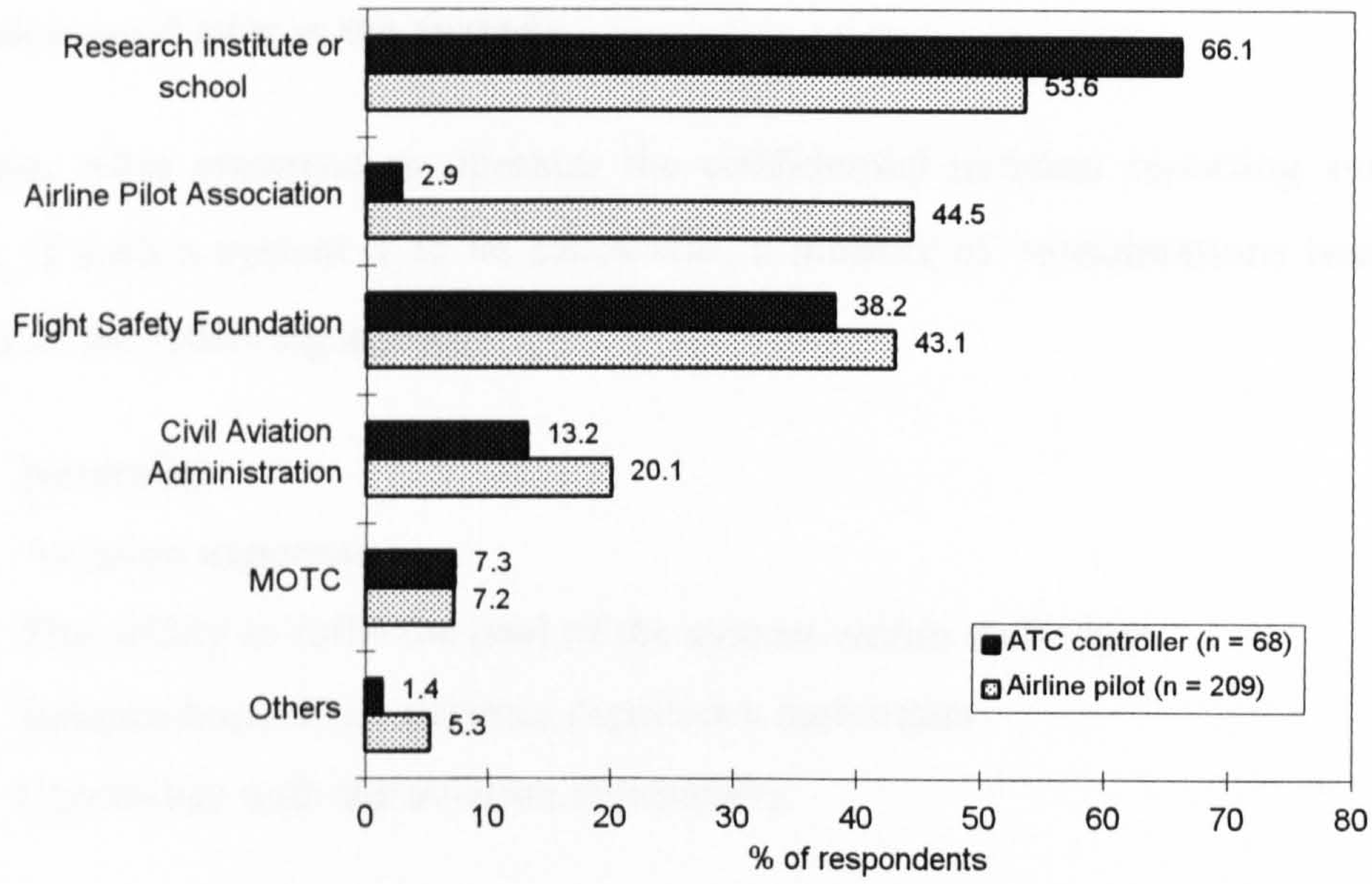


**Figure 7.5 The Responses about the Best Agency of the Incident Reporting System**

(Each respondent may have more than one choice.)

### 7.5.3 Discussion

Creating a new and totally independent agency would be costly. In considering the scale of the current aviation industry in Taiwan, a better option is to compromise by adding the function of confidential reporting to some already established organisation. A suitable receiving agency should have the expertise to operate such a system, and as generally agreed, should be independent from the aviation regulatory authorities and have credibility within the aviation community.

There was discussion at an aviation safety meeting about the selection of a suitable receiving agency to operate a confidential reporting system in Taiwan. However, no consensus was gained over the issue among aviation associations. The survey response indicated that independence from the aviation regulatory authorities was the key determinant for both the airline pilots and the ATC controllers on choosing their ideal receiving agency. Nevertheless, a few airline pilots and ATC controllers still chose CAA or MOTC as the best agency, which could be a result of their lack of understanding of the reporting system. Apart from independence, the expertise of the staff in the potential agency is possibly another important element to be considered. This is discussed later in the chapter.

No matter what organisation operates the confidential incident reporting system in Taiwan, if such a system is to be successful, a number of considerations need to be assessed in the receiving agency:

- Neutrality
- Aviation expertise
- The ability to fulfil the goal of the system within its budget
- Independence from aviation regulatory authorities
- Credibility with the aviation community

## 7.6 About trust of the potential receiving agency

### 7.6.1 Introduction

As described above, an ideal receiving agency should be like a doctor or a priest, one that potential reporters can trust with any sort of problem or secret. In a practical environment, such trust must be rooted on the provision of confidentiality and immunity. This is where the confidence of the aviation community comes from. Without it, invaluable information of incidents would not be uncovered. Thus, the success of this system will depend on the trust the aviation community has in the receiving agency.

### 7.6.2 Results

*Question 9:* *If the incident report-receiving agency is an independent aviation authority / organisation, which provides guarantee of confidentiality and immunity to the reporter, will you voluntarily make an incident report?*

When asked about their willingness to make an incident report if confidentiality and immunity are guaranteed, 84.2% of the airline pilots and 79.4% of the ATC controllers indicated that they "absolutely agree" or "agree" to do it. Whereas 15.8% of the pilots and 20.6% of the ATC controllers checked "it depends". It is surprising to find out that no one chose negative answers on the question. However, the results of the following question draws another picture.

*Question 12:* *If an appropriate agency is chosen, to what extent do you trust that the agency can provide confidentiality to the reporter?*

The responses to this question suggest that nearly 40% of the respondents did not feel that the receiving agency could provide confidentiality to the reporter. Figure 7.6 shows that ATC controllers tended to be significantly less worried about the confidentiality provision than were the airline pilots ($p < .05$, $df = 1$, $X^2_{obt} = 6.49$, $n = 276$). In Figure 7.7, it is also apparent that the Captains were less worried than were the First Officerss, and the difference between them was statistically significant at the .01 level ($p < .01$, $df = 1$, $X^2_{obt} = 8.45$, $n = 209$). Further analysis indicated that experienced pilots were less worried about "leaks" than were inexperienced pilots ($p < .01$, $df = 4$, $X^2_{obt} = 13.66$. $n = 209$, see Appendix L2).

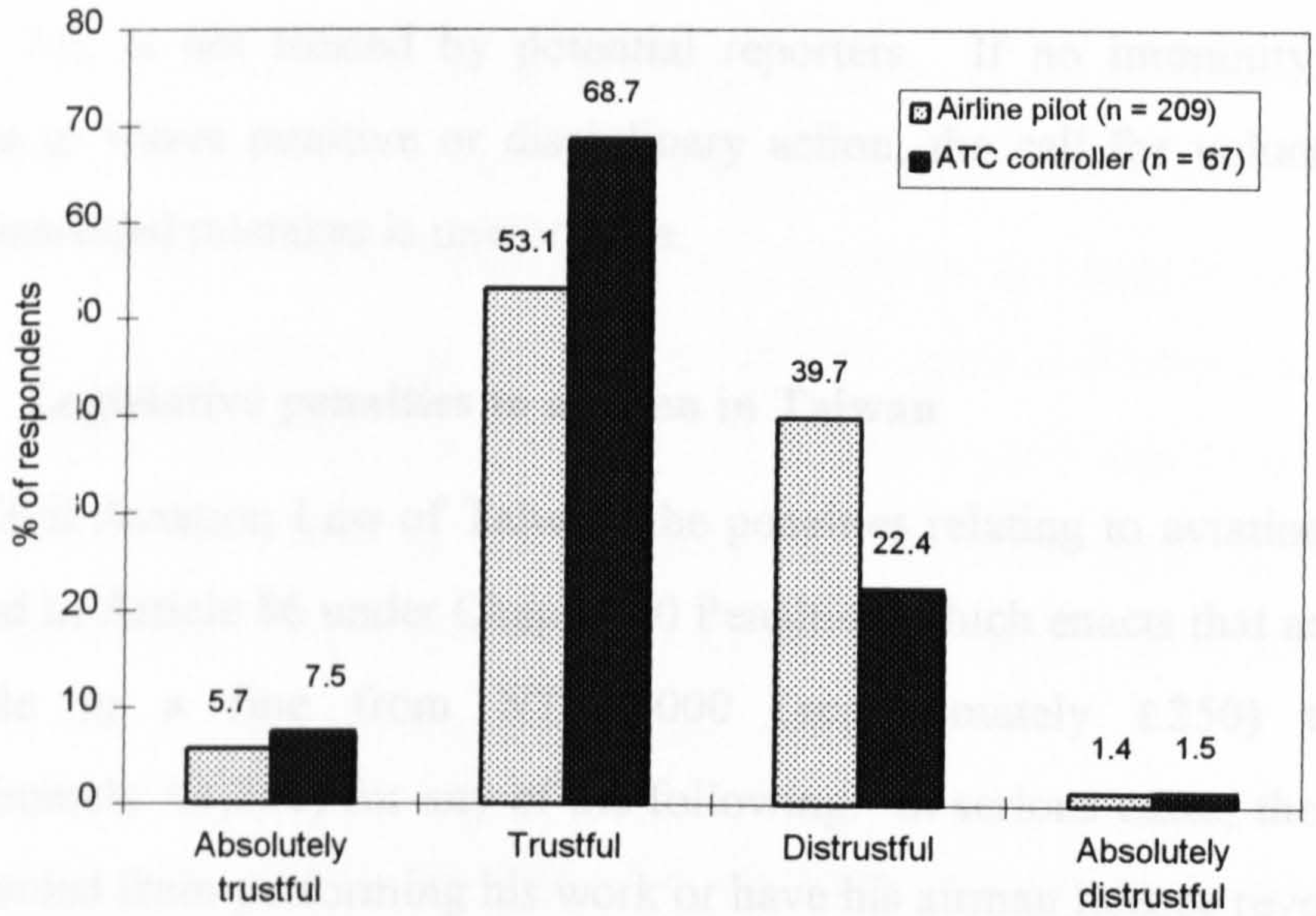


**Figure 7.6 Pilots' and ATC Controllers' Perception about the Trust with the Receiving Agency on Confidentiality Provision**

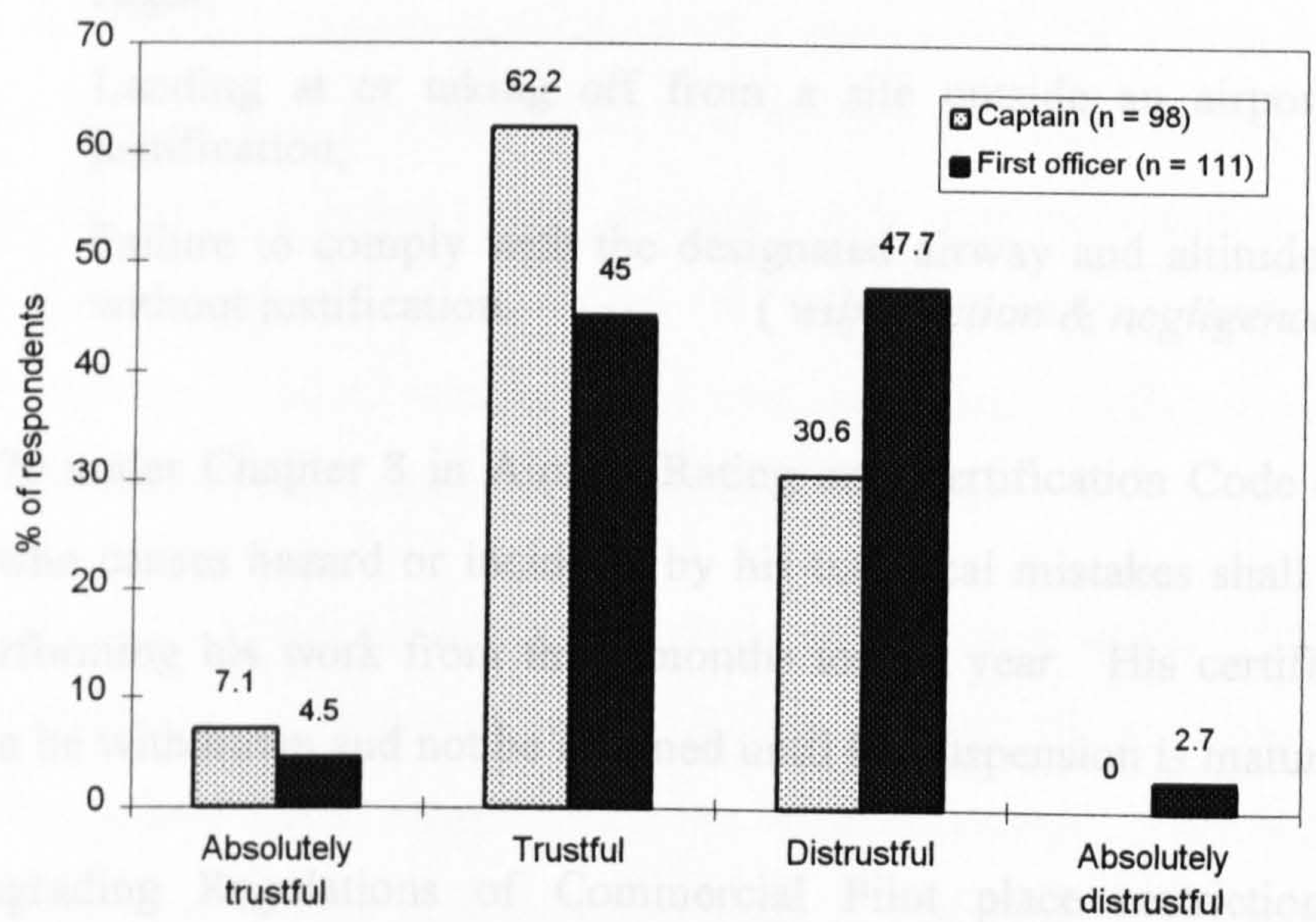


**Figure 7.7 Captains' and First Officers' Perception about the Trust with the Receiving Agency on Confidentiality Provision**

Some of the individual points put forward by interviewees are listed below:

> " I am willing to file an incident report, but the price for it is my future. I do not trust such complicated human relationship in the aviation community." *(fear of bad consequence)*
>
> " The reporter, more often than not, gets hurt at last." *(fear of bad consequence)*
>
> "Don't let the CAA utilise the acquired information from the reporting system to carry out a safety inspection, in particular aiming at special target. " *(the regulatory authority's underatanding and supporting)*
>
> "I am afraid incident reporting will be used to assess individual performance." *(understanding of the system)*
>
> "So far, I have not found any institute that is 'independent and credible' to be the receiving agency." *(quality of the receiving agency)*

### 7.6.3 Discussion

The general view among the respondents was that they would be willing to file a confidential report under the condition that confidentiality and immunity were guaranteed. Unfortunately the promise of confidentiality was simply not accepted by the majority of the aviation community. Some interviewees also doubted that the receiving agency could be independent from the aviation regulatory authorities.

Great care and tact must be exercised in the development of relationships with reporters if a reporting system is to be implemented in Taiwan. The receiving agency should not only be independent from the aviation regulatory authorities, but be able to guarantee confidentiality of reporter identity and promise immunity from punitive action. In addition, it needs to correct the impression of distrust by promulgating the importance of the system, its method of operation, and disseminating information feedback to the aviation community. Otherwise, the aviation community will not have faith in the system, and there will be no system.

## 7.7 A significant legal hurdle

### 7.7.1 Introduction

In a national-level confidential reporting system, the promise of immunity becomes relatively important when the guarantee of complete confidentiality, as described in Section 7.6, is not trusted by potential reporters. If no immunity is offered for reporters to waive punitive or disciplinary action, the call for voluntarily reporting their unintended mistakes is unworkable.

### 7.7.2 Legislative penalties to airmen in Taiwan

In the Civil Aviation Law of Taiwan, the penalties relating to aviation personnel are legislated in Article 86 under Chapter 10 Penalties, which enacts that any airman shall be liable to a fine from NT$10,000 (approximately £250) to NT$50,000 (approximately £1,250) for any of the following. In serious cases, the offender shall be suspended from performing his work or have his airman licence revoked:

1. Flight beyond the limits of the prescribed standards;
2. Failure to carry all the documents required of the aircraft while in flight;
3. Landing at or taking off from a site outside an airport without justification;
4. Failure to comply with the designated airway and altitude in flight without justification. ( *wilful action & negligence* )

Article 70 under Chapter 8 in Airman Rating and Certification Code enacts that an airman who causes hazard or incidents by his technical mistakes shall be suspended from performing his work from three months to one year. His certificate of rating shall also be withdrawn and not be returned until his suspension is mature.

The Upgrading Regulations of Commercial Pilot place restrictions on pilot's upgrading, if any pilot:

- causes aircraft incidents due to his technical mistakes or violation of aviation regulations within the past two years, or
- causes aircraft accidents due to his technical mistakes or violation of aviation regulations within the past one year.

### 7.7.3 Discussion

The above articles and regulations account for the reason why pilots are unwilling to voluntarily report aviation incidents or accidents. Under the present regulations, their fear of the penalties which incident reporting might bring seems to make sense. In an area which the industry lacks trust in the system, such as Taiwan, it is advisable to apply legislative protection to reporters. It is also a good idea to modify the above law, codes and regulations so that they are better served on reporting motivations. As some pilots interviewed expressed, they additionally hoped the system could change or modify the punishment approach in their airlines.

To aviation regulatory authorities, the establishment of an aviation confidential incident reporting system is likely to demand change on their previous rules or procedures as well as their attitude towards using the information. For example, it is essential to announce the guarantee for reporters from punitive or disciplinary action in order to stimulate reports that reveal of human error and systematic weaknesses. They also have to give an undertaking that the focus of incident investigations is on assessing the whole aviation safety standard rather than individual performance. In essence, the emphasis is to encourage full and candid reporting of incidents and unsafe events and to avoid seeking blame and punishment, so that early identification of problems and effective remedial action are attainable.

Experience shows that the primary motivation for reporting to US ASRS is immunity not confidentiality. However, a significant portion of reporting is to waive disciplinary action rather than to improve aviation safety. This should be given consideration if a similar immunity provision is intended to be established in the Taiwanese system.

Additionally, two of the senior CAA officers interviewed mentioned that although they did support the establishment of a reporting system, what worried them most was the speed of the enactment of a law. This is because the amendment of law always takes a long time to be passed in the Legislative Assembly and MOTC.

## 7.8 About feasibility opinions (the support extent of airline community)

### 7.8.1 Results

*Question 8:* *Do you think a confidential reporting system or its related research paper will help to improve aviation safety?*

*Question 14:* *To what extent do you think such a confidential reporting system is needed in Taiwan?*

The responses to these two questions suggests that the majority of the pilots and the ATC controllers believed that confidential reporting systems would help to improve aviation safety (pilots: 92.6%; ATC controllers: 98.5%) and there was a need to establish such a reporting system in Taiwan (pilots: 96.8%; ATC controllers: 97.7%).

*Question 13:* *If an independent incident report-receiving agency is appropriately chosen, confidentiality and immunity to the reporter are also guaranteed, do you think it is feasible to implement a Taiwanese confidential reporting system in the next two years?*

More than 60% of the pilots and ATC controllers indicated that it was "absolutely feasible" or "feasible" to implement a Taiwanese confidential reporting system in the next two years (see Table 7.12). Several of those interviewed showed their strong support by saying that "Such a system should be established quickly and publish its feedback magazines."

It appears that more Captains (73.7%) than the First Officerss (64.3%) gave positive responses on the question. The percentages saying that the system was feasible were about the same between military-trained pilots and *Ab-initio* trained pilots. However, the difference of the percentage on negative answers were quite considerable, with only 3.8% of the Ab-initio trained pilots but 11.4% of the military-trained pilots indicating their disagreement on the question. "No comment" was checked the most by the First Officerss, corresponding to 28.6%.

**Table 7.12 Breakdown of Responses According to the Position and Background about the Feasibility of Implementing a Taiwanese Confidential Reporting System in the Next Two Years**

| | Absolutely feasible | Feasible | No comments | Not feasible | Absolutely not feasible |
|---|---|---|---|---|---|
| Pilots (n = 211) | 13.3 % | 55.5 % | 21.8 % | 8.1 % | 1.4 % |
| ATC controller (n = 68 ) | 17.6 % | 57.4 % | 19.1 % | 4.4 % | 1.5 % |
| Captain (n = 99 ) | 10.1 % | 63.6 % | 16.2 % | 8.1 % | 2.0 % |
| First officer (n = 112) | 16.1 % | 48.2 % | 28.6 % | 8.0 % | 0.9 % |
| Military background (n = 158) | 11.4 % | 56.3 % | 20.3 % | 9.5 % | 1.9 % |
| *Ab-initio* background (n = 53) | 18.9 % | 52.8 % | 24.5 % | 3.8 % | 0 % |

*Question 11:* *If the confidential reporting system is established in Taiwan, what are the possible reasons that might result in your unwillingness to make an incident report?*

When asked their possible reasons for not submitting an incident report, most of the respondents expressed their main worries on negative consequences (see Table 7.13).

**Table 7.13 The Possible Reasons Resulting in Respondents' Unwillingness to Make a Voluntary Incident Report**

| | Pilot (n = 211) | | ATC Controller (n = 68) | |
|---|---|---|---|---|
| | Freq. | Pct. | Freq. | Pct. |
| Might cause negative consequences | 139 | 66.5 % | 46 | 67.6 % |
| Distrust the confidentiality | 88 | 42.3 % | 24 | 35.2 % |
| Too much time on paper work | 74 | 35.6 % | 33 | 48.5 % |
| Company or unit might not want us to report | 72 | 34.6 % | 15 | 22.0 % |
| Personnel of the system are not professional | 72 | 34.6 % | 34 | 50.0 % |
| Fear of punitive action | 67 | 32.2 % | 28 | 41.2 % |
| Do not know what the system can do | 36 | 17.3 % | 13 | 19.1 % |
| I am not sure what can be reported | 21 | 10.1 % | 4 | 5.8 % |
| Lose face | 17 | 7.7 % | 9 | 13.2 % |
| Do not think it will help to improve safety | 6 | 2.9 % | 5 | 7.3 % |

Each respondent may have more than one choice.

Of the pilots and ATC controllers, more than 35% expressed their doubt about the confidentiality provided by the receiving agency as well as their unwillingness to spend too much time on paper work. The expertise of staff in the receiving agency and the support of the airlines are two other important reasons resulting in their unwillingness to report incidents.

Based on the rank order of importance, the reasons for their unwillingness to make an voluntary incident report were:

1. Might cause negative consequences
2. Too much time on paper work
3. Distrust the confidentiality
4. Personnel of the system are not professional
5. Company or unit might not want us to report
6. Fear of punitive action
7. Do not know what the system can do
8. Lose face
9. I am not sure what can be reported
10. Do not think it will help to improve safety

Below are some transcripts of the interviews about their opinions towards setting up an incident reporting system. Fear of bad consequences or punitive action being taken against the individual were mentioned the most. Some interviewees, moreover, stressed that the success of the system depended heavily on the positive attitude of the aviation regulatory authorities.

> "Although legislative protection can guarantee reporters from disciplinary action, it cannot protect the reporters from negative consequences, such as receiving threats from the one being reported."
>
> "It is likely to be prevented by aircrews, such as the Captain or Flight Engineer."
>
> "It depends on whether reward is provided appropriately."

> "Whether the aviation regulatory authorities give their encouragement and support needs to be observed."
>
> "Correct concept should be deeply rooted in fundamental education. Aviation regulatory authorities also need to have correct concept and attitude about the system."
>
> "The establishment of a Taiwanese reporting system is like other concepts. The idea is good, but there are always discrepancies in translating theoretical treatments of the concept into practical action."
>
> "Reporting is unnecessary to have too much paper work."

### 7.8.2 Discussion

This survey of the respondents showed that there was strong support for the introduction of a voluntary confidential incident reporting system, but the support was conditional. The system was considered to be feasible under the conditions that the receiving agency was appropriately chosen, and that confidentiality and immunity to the reporter were also guaranteed.

Existing systems vary in their target populations, but all include airline pilots and ATC controllers. From the viewpoint of eliciting safety information, the more the target populations are included, the better. Considering the funds a large-scale system might need and the complexity it would involve, it is therefore suggested that initially the target population of reporters should merely include commercial pilots and ATC controllers. Then, other populations can be added if the initial scheme is successful and funding increases.

The findings of the survey show that a few psychological obstacles need to be surmounted before implementing a Taiwanese confidential reporting system. The potential reporters need to be convinced that submitting an incident report on their own performance will not result in any negative consequences. On the contrary, it must be seen that the information will be effectively utilised and thus contribute to aviation safety. Air carriers, air traffic control providers, and aviation regulatory authorities, at the same time, need to form a positive attitude towards the reporting system and towards using the information to bring about changes to equipment, procedures, and training that have already been approved, licensed, or authorised by them.

A surprisingly small number of the respondents were worried about losing face for admitting their mistakes. The concept of face has long been related to Chinese hierarchical social structure. Ho (1976) elaborates the importance of the concept of face in Chinese social system: (Chang and Holt, 1994)

> Face is the respectability and/or deference which a person can claim for himself from others, by virtue of the relative position he occupies in his social network and the degree to which he is judged to have functioned adequately in that position as well as acceptably in his general conduct; the face extended to a person by others is a function of the degree of congruence between judgements of his total condition in life, including his actions as well as those of people closely associated with him, and the social expectations the others have placed upon him.

It is thus expected that the respondents with higher rank and seniority structure should give "lose face" as an important reason for non reporting. However, data gained from this survey showed that "lose face" was not the major concern for both the pilots and ATC controllers, presumably because the other reasons were likely to influence their job security and increase workload. Nevertheless, it is believed that such a cultural conflict caused by keeping up face, as described in Section 5.2, can not be ignored when reporters make a voluntary incident report.

## 7.9 About sharing safety information via the Internet

### 7.9.1 Introduction

The characteristics of openness, interaction, availability at any time, and user friendlyness have made the Internet one of the most powerful media in the world. In aviation, it is utilised to check flight numbers, arriving and departing flight information, airport information, and meteorological conditions. To aviation safety, the facility of electronic mail may offer the aviation community an interactive and bilateral channel to exchange their perceptions of safety and experience on hazardous events. Internet safety web, moreover, may provide aviation community an access to safety information. For example, it may publish a column to introduce a series of safety topics, providing aviation community or general public up-to-date or imminent aviation information.

Digital computers are omnipresent. In the flight cockpit, they play an inevitable role as the third pilot. The questions in the section are designed to establish how personal computers are used by the respondents at home and what they think of transferring aviation safety information from the Internet.

### 7.9.2 Results

*Question 1:* *Do you have your own personal computer?*

*Question 2:* *How often do you use computer at home?*

The point of these two question was to assess the usage of a personal computer by the selected target groups of the Taiwanese aviation community. 49.5% of the pilots owned a personal computer at home. Among them, 59.6% always or often used it. Whereas 43.3% of the ATC controllers possessed a personal computer at home, 55.2% of whom indicated that they "always" or "often" used it.

**Table 7.14 Breakdown of Responses about the Possession of a Personal Computer**

| | Pilot ( n = 186 ) | | ATC controller ( n = 67 ) | |
|---|---|---|---|---|
| | Frequency | Percent | Frequency | Percent |
| Yes | 92 | 49.5 % | 29 | 43.3 % |
| No | 94 | 50.5 % | 38 | 56.6 % |

*Question 3:* *Is your personal computer connected to the Internet?*

This question was intended to establish how many respondents gained access to the Internet. The response indicated that only about one-fourth of the pilots and one-third of the ATC controllers had their personal computers connected to the Internet (see Table 7.14).

**Table 7.15 Breakdown of Responses about the Connection of Personal Computer to the Internet**

| | Pilot ( n = 186 ) | | ATC controller ( n = 67 ) | |
|---|---|---|---|---|
| | Frequency | Percent | Frequency | Percent |
| Yes | 51 | 27.4 % | 23 | 34.3 % |
| No | 135 | 72.6 % | 44 | 65.7 % |

*Question 5:* *Are you willing to receive safety and its related information through computer?*

The response suggested that a majority of the respondents favoured the idea of receiving safety information by computer, with the ATC controllers slightly outnumbering the pilots (see Table 7.15). A relatively small percentage of the respondents indicated their unwillingness, and it was noteworthy that no one expressed strong objection.

**Table 7.16**
**Respondents' Willingness to Access to Safety Information via Computer**

| | Absolutely willing | | Willing | | Unwilling | | Absolutely unwilling | |
|---|---|---|---|---|---|---|---|---|
| | Freq. | Pct. | Freq. | Pct. | Freq. | Pct. | Freq. | Pct. |
| Pilots (n = 174) | 78 | 44.8% | 90 | 51.7% | 6 | 3.4% | 0 | 0% |
| ATC controller (n = 59) | 31 | 52.5% | 27 | 45.8% | 1 | 1.3% | 0 | 0% |

*Question 6:* <u>*Are you willing to offer your flying experience or safety suggestions on the Internet?*</u>

The question was intended to understand whether the respondents accepted the notion of information exchange by computer. It appeared that most respondents tended to agree with the notion, with roughly equal support being given by each of the two groups surveyed (see Figure 7.8). However, a considerable number of the respondents did not take side. 30.5% of the pilots and 23.7% of the ATC controllers chose the neutral answer, "it depends".

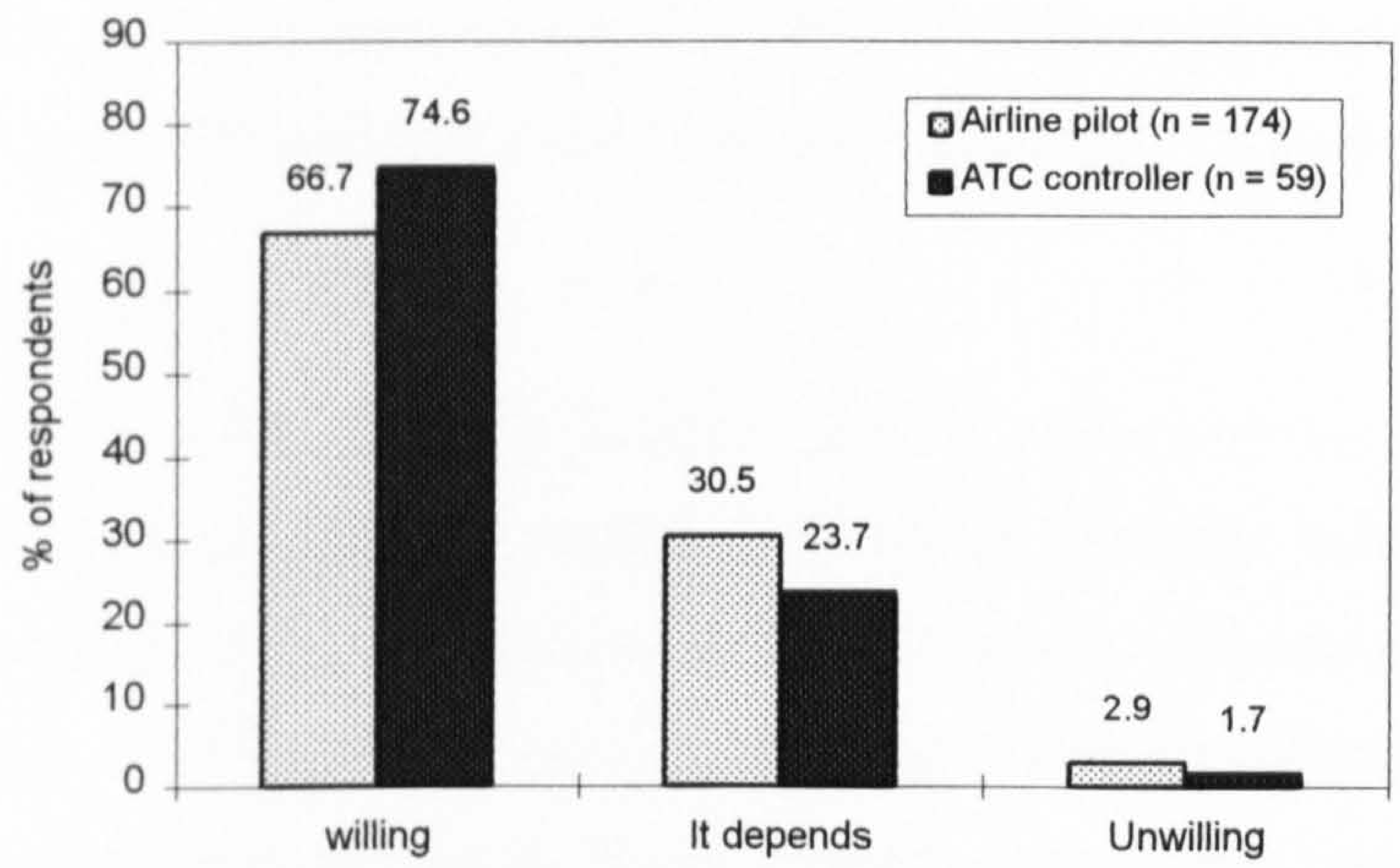


**Figure 7.8 Respondents' Willingness to Offer Safety Suggestions on the Internet**

### 7.9.3 Discussion

The survey response suggested that the respondents regarded electronic access to safety information and information exchange by computer as acceptable. Additionally, electronic communications are available through Internet in some existing confidential reporting systems. Considering the expectation of electronic services in the aviation community, more systems are building up or considering building up such a network to cater for the trend of digital revolution.

It is thus suggested that the CAA-Taiwan and the airlines in Taiwan should consider early establishment of an e-mail network for exchange of safety information. The FSF-Taiwan (Flight Safety Foundation) maybe is in a good position to facilitate establishing such a communications net. There should be established a safety library, electronically accessible by any of the airlines or the CAA. Again, an independent agency could facilitate this service for the CAA and the airline community, ensuring its growth and currency.

# CHAPTER 8

# CONCLUSIONS AND RECOMMENDATIONS

> "Since brevity is the soul of wit, and tediousness the limbs and outward flourishes, I will be brief."
>
> \- Shakespeare, *Hamlet*, II, 2

## 8. Overview

This chapter outlines the major findings of the whole study, and provides some suggestions for further research on airline safety. Recommendations for improving safety, based on the information gained from the two studies, are made.

## 8.1 Conclusions

1. There is considerable variation in airline fatal accident records among different regions. Australasia, North America, and Europe have the best safety records. Unfortunately, safety performance is markedly worse in the other regions, amongst which Africa has the worst safety record. Similarly, the chances of accidents occurring for foreign aircraft in North America and Europe were comparatively lower than in other regions, such as Asia, South America, and Africa.

2. Geographical or organisational variations in the definition of accidents are likely to create misleading analyses and misrepresentation of accident statistics.

3. From a review of Asian and Taiwanese accidents occurring between 1983 - 1994, the most frequently occurring factors contributing to accidents were identified as "failure to follow regulations or procedures", "failure to cross-check/co-ordinate", "lack of situational awareness" and "omission of action/inappropriate action". All of these causal factors were related to failure of human performance.

4. Most pilot respondents, especially those who were military-trained First Officers in regional airlines, were negative about the influence of safety staff and their position. Two-thirds of the interviewees stated they would rather report a safety concern to someone other than flight safety staff, because they thought that the

flight safety staff were not delegated with enough influence to deal with unsafe practices.

5. More than half of the respondents agreed that the policy of their companies encouraged voluntary safety reporting, but over half did not agree that crews were willing to report hazards or incidents. This was mainly because they worried about the negative consequences accompanied by reporting (see List entry 19). Further analysis showed that there were wide variations among the comparison groups. Approximately two-thirds of the First Officers and *Ab-initio* trained pilots disagreed that crews were willing to report hazards / incidents; however, only one-third of the Captains and about half of the military-trained pilots thought so.

6. With regard to the experiences of working with expatriate pilots, the most quoted advantage was the presence of less pressure, whereas the major frustrations stemmed from differences of language and culture.

7. The analysis of the survey data suggested that management commitment to safety was voiced at every airline, but the extent to which the commitments are actually realised in practice could not be determined from the survey findings. As there is no simple or universal solution for resolving cultural conflicts and confusion, actual managerial practices require continuous efforts to be applied on reducing the impact of discordant culture on safety.

8. From the survey, more than half of respondents were not satisfied with the reward system in their airlines. There was call for abating punishments and enhancing rewards for good teamwork rather than individual performance. Also it was suggested that rewards should be offered immediately to enhance their effectiveness.

9. The two main reasons for not attending aviation safety conferences were the existence of a language gap and workload increase. Language gaps lead to lack of involvement, while workload increases resulted from the requirement for the conference participants to file a report immediately after attendance. On the other hand, the most common reasons for attending aviation safety conferences were that

they helped to increase knowledge, and that there was no detrimental influence on flight schedules.

10. A considerable number of the respondents reported negatively about the allocation of greater resources in the area of safety, with regional-airline pilots being less enthusiastic than international-airline pilots.

11. Flight training and operating standards were perceived as being the most important factors in airline safety management for both Asian and Taiwanese respondent pilots, while top management was viewed as the most important factor in the opinion of CAA officer respondents.

12. Due to fear of punishment or suspension, the respondents would rather not to report unsafe acts, if possible, or else would just talk about them with others in private.

13. Some respondents noted that there was a lack of flight standards and inspection personnel in the subject country's CAA. There needs to be some incentive established to encourage careers in government civil aviation. In order to augment staff numbers, it was advisable to provide better salaries in order to bridge the differentials between civil service positions and airline jobs. More safety training, in particular accident investigation training, was also suggested to maintain a high level of performance and provide updated information to safety professionals.

14. In many cases limited English language fluency inhibited the acquisition of aviation information and was a leading problem when training abroad. More than half of the interviewees indicated that communication difficulties hindered them when asking questions, and three-fourths admitted that it influenced their learning speed.

15. Significant differences were found between the pilots and ATC controllers about their experience of incident reporting, with more airline pilots tending to participate than ATC controllers. Subsequent analysis revealed that the Captains were more likely to report incidents than the First Officers.

16. Although airline pilots were more inclined to contribute to an incident reporting system, they expressed less support than ATC controllers on the possibility of

voluntarily reporting incidents under the current situation. This was because the pilot's closer involvement in hazardous events made them more likely to suffer adverse consequences.

17. In comparison with the Captains, the First Officers not only contributed less to incident reporting systems but also indicated that there was a lower incentive for them to report.
18. The survey responses indicated that details of foreign voluntary aviation incident reporting systems and their publications were not well known in the subject aviation community. Airline pilots, however, were slightly more aware of them than ATC controllers.
19. The four most important reasons for not reporting incidents were "fear of negative consequences", "spending too much time on paper work", "distrust of the confidentiality guarantee", and "lack of professional personnel in the system"
20. The promise of confidentiality is simply not accepted by the majority of the aviation community. Nearly two-fifths of the respondents did not feel that the receiving agency could provide an adequate guarantee of confidentiality for the reporter, with the airline pilots being significantly more concerned than the ATC controllers. Further analysis suggested that the First Officers tended to be significantly more worried about the confidentiality provision than were the Captains.
21. The majority of the pilots and the ATC controllers believed that confidential reporting systems would help to improve aviation safety (pilots: 92.6%; ATC controllers: 98.5%) and that there was a need to establish such a reporting system in the subject country (pilots: 96.8%; ATC controllers: 97.7%).
22. More than three-fifths of the pilots and the ATC controllers indicated that it was "absolutely feasible" or "feasible" to implement a national-level confidential reporting system in the subject country in the next two years. The survey response also suggested that the respondents regarded electronic access to safety information and information exchange by computer as being acceptable.

23. According to the pilot and ATC controller respondents, the three most popular choices for the type of body needed to act as a receiving agency were "research institute", "Flight Safety Foundation", and "Airline Pilot Association".

24. A substantial number of the respondents (more than 90%) were willing to receive and exchange safety information via the Internet.

## 8.2 Recommendations

1. To demonstrate the commitment to safety and to create an improved safety culture, it is recommended that the airline safety department should be an autonomous unit, and it would be preferable for it not coming under the flight operations or maintenance departments.

2. Safety surveys should be conducted to provide the regulator and the regulated (airlines) with more information about the underlying safety integrity of organisations than inspection-based processes can provide. Their aim should be to locate and evaluate problems, so that remedial actions can be taken based on the priorities of each problem.

3. Any excessive concentration on punishment of a pilot's unsafe performance might prevent a clear understanding of how other underlying factors cause human error in the first place. The overall objective of any safety program should be able to identify latent factors early in the process so that the root causes of "human error" are not ignored or inadvertently overlooked. It is recommended for both airlines and the CAA to review their present punishment procedures and use punishment judiciously with the overall objective in mind.

4. A successful flight safety programme must consider all aspects of anomalous airline operations, not just accidents and more serious incidents.

5. According to the experience of confidential reporting systems in operation, it is recommended that continuous education and promotion be provided to increase the aviation community's awareness and understanding of any new a national-level system. Before the establishment of such a system, it is suggested to actively invite the participation of the Airline Pilot Association, Flight Safety Foundation-Taiwan

and relevant research institutes to discuss every detail of implementation. In order to breed trust and strengthen consensus, it is also suggested that the system be introduced for a test period of two years, then its achievements should be fully evaluated.

6. English language fluency should be encouraged as a means to access the abundant safety and operations documentation and other literature that is available. At the same time, the provision of bilingual manuals, regulations and safety information is recommended to avoid misunderstanding.

7. There is a need for all airlines to include Cockpit Resource Management (CRM) training in their safety programmes with the purpose of improving cockpit co-ordination and communications.

8. It is important that the concept of sharing safety information in the subject airline community should be fostered in order to spot safety problems before they cause accidents, as any one accident will affect everyone in the aviation community.

9. Based on the experience of existing confidential aviation reporting systems, the keys to ensure the success of an incident reporting system lie with the guarantees of confidentiality and immunity, together with rapid information feedback. At the same time, the receiving agency of the system should be independent from the aviation regulatory authority and be capable of winning the confidence of the aviation community.

10. Electronic mail and the Internet Safety Web are recommended to be used for saving time in report submissions and processing. In addition, a carefully managed electronic reporting system may be used to exchange confidential information among various safety focal points, and to alert the aviation entire community to safety problems within a short period of time.

11. With a view to establishing regional co-operation and under consideration of the personnel and equipment required, a regional aviation safety oversight programme is recommended to ensure that civil aviation in Asia-Pacific meets international standards. Such cross-boarder co-operation can be practised to improve existing

regulations, harmonise regulations among the nations, standardise methods of determining airworthiness, share safety information, and train inspectors and investigators with same programme to save training cost.

12. Safety is an endless job. Another survey is recommended to evaluate the improvement of safety management after receiving the feedback of the survey. In order to increase integrity, it is also suggested that the subjects should be expanded to include ground and cabin crew.

13. A follow-up study is needed to probe more deeply the problems caused by language barriers, such as in what situation they usually occur, and how they influence the effectiveness of training and flying. Hopefully, a better understanding of the language barriers will foster the provision of possible solutions.

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## APPENDIX A: Asian Airline Accident Data (1983-1992)

## Asian Airline Accident Data

| Date | Aircraft | Carrier | Flight Phase | Location | Accident Type |
|---|---|---|---|---|---|
| 02/06/83 | F28 | Garuda | 2 | Tanjung Karang, Indonesia | RTO overrun |
| 18/12/83 | A300 | MAS | 8 | Kuala Lumpur, Malaysia | Landed short in swamp |
| 19/12/83 | B747 | JAL | 9 | Anchorage, USA | Hit truck on runway |
| 23/12/83 | DC10 | KAL | 2 | Anchorage, USA | Collision with light twin |
| 27/01/84 | F28 | Garuda | 9 | Pangkalpinang, Indonesia | Veered off runway |
| 06/06/84 | B737 | Indian Air | 9 | Calcutta, India | Veered off runway |
| 11/06/84 | DC9 | Garuda | 9 | Jakarta, Indonesia | Hard LDG-fuselage separation |
| 03/06/84 | BAC111 | PAL | 2 | San Jose, Philipine | The aircraft was overweight |
| 04/08/84 | BAC111 | PAL | 9 | Tacolban, Philippine | Overrun into shallow seawater |
| 30/12/84 | DC9 | Garuda | 9 | Denpasar, Indonia | Departed runway |
| 08/02/85 | B737 | Indian Air | 9 | Calcutta, India | Gear up landing |
| 12/02/85 | DC9 | JAS | 9 | Hanamaki, Japan | Veered-off runway on landing |
| 19/02/85 | B747 | CAL | 5 | Near San Francisco, USA | Stall, roll, & rapid descent |
| 15/04/85 | B737 | Thai Air | 7 | Phuket, Thailand | CFIT on initial approach |
| 12/08/85 | B747 | JAL | 4 | Mt Osutaka, Japan | Control loss-AFT BLKHD failure |
| 20/08/85 | BAC111 | PAL | 9 | Tacloban, Philippine | Over runway |
| 29/08/85 | BAC111 | PAL | 9 | Manila, Philippine | Hard LDG-NLG collapse |
| 12/10/85 | MD80 | Korean Air | 9 | Seoul, Korea | Landing overrun |
| 15/01/86 | B737 | India Air | 8 | Trichy, India | Wing tip strike on approach |
| 16/02/86 | B737 | CAL | 9 | Makung Island, Taiwan | Crashed in ocean during G/A |
| 29/09/86 | A300 | Indian Air | 2 | Madras, India | RTO/ENG. fire-overshot runway |
| 02/01/87 | F28 | Pelita | 9 | Pinangkampai, Indonesia | Landed short |
| 04/04/87 | DC9 | Garuda | 8 | Medan, Indonesia | Fatal crash on approach |
| 31/08/87 | B737 | Thai Air | 7 | Phuket, Thailand | Stall-crashed into water |
| 19/09/87 | A300 | PAL | 9 | Manila, Philippine | Airplane overshot runway |
| 18/01/88 | L1011 | All Nippon | 9 | Sapporo, Japan | Veered off runway into snow |
| 30/05/88 | B737 | JTA | 2 | Shimojishima, Japan | Veered off runway on takeoff |
| 19/06/88 | B737 | Indian Air | 9 | Delhi, India | Gear up landing |
| 09/10/88 | B747 | Garuda | 2 | Bangkok, Thailand | A/C halted too late |
| 19/10/88 | B737 | Indian Air | 8 | Ahmadabad, India | Terrain impact, final approach |
| 21/07/89 | BAC111 | PAL | 9 | Manila, Philippine | Landing overrun |
| 27/07/89 | DC10 | Korean Air | 8 | Tripoli, Libya | Crashed on final approach |
| 26/10/89 | B737 | CAL | 3 | Hualian, Taiwan | Flew into mountain after T.O. |
| 25/11/89 | F28 | Korean Air | 2 | Seoul, Korea | Crashed following rotation |
| 14/02/90 | A320 | Indian Air | 8 | Bangalore, India | Crashed short of airport |
| 24/03/90 | L1011 | Cathay Pac | 9 | Tokyo, Japan | Hard landing-fuel leak-evacuation |
| 07/05/90 | B747 | Air India | 9 | Delhi, India | Engine separation after touch down |
| 11/05/90 | B737 | PAL | 1 | Manila, Philippine | Explosion in center fuel tank |
| 27/05/90 | A300 | Thai Air | 9 | Manila, Philippine | Plane ran off end of runway |
| 05/11/90 | A300 | Air India | 1 | Goa, India | Hard landing, veered off runway |
| 15/11/90 | B707 | PIA | 2 | Peshawar, Pakistan | Rear main wheel axle broke |
| 18/03/91 | A300 | PIA | 9 | Islamabad, Pakistan | Over runway in heavy rain |
| 13/06/91 | B727 | Korean Air | 9 | Taegu, Korea | Gear up landing |
| 16/08/91 | B737 | Indian Air | 7 | Imphal, India | Hit hill on VOR approach |
| 29/12/91 | B747 | CAL | 4 | Taipei, Taiwan | Lost #3 and #4 engines after T.O. |
| 10/01/92 | B737 | Air Lanka | 9 | Madras, India | Gear Collapse-hard landing |
| 16/01/92 | B767 | Asiana | 9 | Cheju Island, korea | Hard landing-fuselage damage |
| 31/07/92 | A310 | Thai Air | 9 | Kathmandu, Nepa | Crash into mountain-CFIT |
| 28/09/92 | A300 | PIA | 8 | Nr. Kathmandu, Nepal | Hit high ground on approach |

**APPRENDIX B :** Interview List

| Name | Job Title | Company |
|---|---|---|
| Capt. M. Chen | Manager, Flight training centre | China Airlines |
| Capt. R. P. Tzou | Flight safety manger | Far Eastern Air Transport |
| Capt. M. Y. Yin | Executive Secretary | F S F-Taiwan |
| Capt. K. R. Qualls | Assistant to Director, Operations | China Airlines |
| Capt. C. C. Fan | Chief pilot | China Airlines |
| Mr. C. Z. Chao | First Officer | EVA Air |
| Capt. Y. T. Teng | Training Captain | Makung Airlines |
| Mr. S. F. Wen | Specialist, Flight operations | Formosa Airlines |

## APPENDIX C : Questionnaire for Asian airline pilots

AVIATION SAFETY IS ----- A SHARED REPONSIBILITY !

Dear Sir/Madam,

Safety is an endless job. Safety is also an invaluable property of an airline.

We are conducting research into airline safety management in Asia. As you always look for ways of improving aviation safety, it would be greatly appreciated if you could complete this questionnaire enclosed and offer us YOUR OPINIONS regarding the airline safety management.

All replies will be treated in confidence. Results of the survey will be calculated only in aggregate form so that neither airlines nor persons can be identified.

We hope you will find time to make a contribution to this research and thank you in advance. The summary of the survey will send to you if you request.

Yours faithfully,

Hero Ho
Research Associate
College of Aeronautics

A Frank Taylor
Director
Cranfield Aviation Safety Centre

AIRLINE SAFETY : It is about lives saved and lives lost.

# NO SAFETY, KNOW PAIN !

# KNOW SAFETY, NO PAIN !

## Airline Safety Management

### Questionnaire

**Just several minutes** of your time could help complete this questionnaire which is part of a research study on airline safety management. You will receive a summary of the results if you tick the box below.

☐ Please send me a survey summary.

In answering the questions, please give <u>your personal view</u>, which may not necessarily reflect your company's "official view". **All information given will be treated as strictly confidential. Results of the survey will be counted only in an aggregate form so that neither airlines nor persons can be identified.**

Name (optional):

Position in your Company:

Working experience in Aviation :
☐ less than 2 years ☐ 2 - 5 years ☐ 6 - 10 years
☐ 11 - 15 years ☐ 16 - 20 years ☐ more than 20 years

Flying background : (If you have)
☐ Ab - initia Training
☐ Military
☐ General aviation

Airline (optional):

**Please circle the number** as appropriate to indicate your opinion

| **I. Organisation structure** | **strongly disagree** | | | | | **strongly agree** | **I don't know** |
|---|---|---|---|---|---|---|---|
| 1. In the past several years, your company has undergone a significant expansion in the scale of its operations. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. Functional responsibility for safety is clearly placed. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. The influence of safety staff is strong. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. The position of safety manager or personnel in your company's hierarchy is appropriate. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

| **II Management styles** | **strongly disagree** | | | | | **strongly agree** | **I don't know** |
|---|---|---|---|---|---|---|---|
| 1. Top management is dedicated to supporting safety policies and events. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. Operations managers are strongly involved in the safety events. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. The safety manager/personnel have direct access to top management. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. Reward system for safety is well organised. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. The safety inspection program in your own airline is satisfactory. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

| **III. Organisational climate** | **strongly disagree** | | | | | **strongly agree** | **I don't know** |
|---|---|---|---|---|---|---|---|
| 1. In general, the awareness of safety is good in your company. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. Channels for communication are accessible in your company. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. Flight and ground crews co-ordinate well in your company. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. The company's policy encourages voluntary safety reports from flight/ground crews. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. Crews are willing to report hazards/incidents. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

| **IV. Operational standards and training** | **strongly disagree** | | | | | **strongly agree** | **I don't know** |
|---|---|---|---|---|---|---|---|
| 1. Your company makes strong efforts to standardise checklists and manuals in accordance with its policy. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. The selection criteria for flight crews are high. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. The quality of recurrent training is very good. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. The working experience of qualified crew members is high. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. Human factors training is effective. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

PLEASE MAKE SURE YOU HAVE ANSWERED ALL THE QUESTIONS. THANK YOU !

| **V. Resource availability** | strongly disagree | | | | | strongly agree | I don't know |
|---|---|---|---|---|---|---|---|
| 1. Your company responds well in terms of changes in policies and procedures after any incident/accident happened. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. Your company absorbs safety-related information from the industry well. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. Your company maintains hazard/ incident/accident data very well. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. Your company enthusiastically participates in the aviation safety organisations and meetings. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. Your company provides very good quality safety-related information. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

| **VI. Indicate your opinion of the importance to airline safety of the following :** | least important | | | | | most important |
|---|---|---|---|---|---|---|
| 1. Top management | 1 | 2 | 3 | 4 | 5 | 6 |
| 2. Organisational structure | 1 | 2 | 3 | 4 | 5 | 6 |
| 3. Organisational climate | 1 | 2 | 3 | 4 | 5 | 6 |
| 4. Resource availability | 1 | 2 | 3 | 4 | 5 | 6 |
| 5. Operational standards | 1 | 2 | 3 | 4 | 5 | 6 |
| 6. Training | 1 | 2 | 3 | 4 | 5 | 6 |
| 7. The role of Aviation Regulatory Authority | 1 | 2 | 3 | 4 | 5 | 6 |
| 8. Others (Please specify) | 1 | 2 | 3 | 4 | 5 | 6 |

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| **VII. Organisational Effectiveness** | strongly disagree | | | | | strongly agree | I don't know |
|---|---|---|---|---|---|---|---|
| 1. Your company has invested a lot in safety improvement. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. The safety criteria in your company are strict. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. Your company handles emergency situations effectively and efficiently | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. Your company is proud of its safety record. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. Image of your company's overall service is very good. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

| VIII. The role of Aviation Regulatory Authority and the investigation agency | strongly disagree | | | | | strongly Agree | I don't know |
|---|---|---|---|---|---|---|---|
| 1. Its pace of response to technological change is good. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. Its follow-up to check compliance with its safety standards is good. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. Its capacity to guide effectively the adequate training of airlines is good. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. It provides adequate safety information to airlines. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. Its investigators are qualified to the level of advanced technology aircraft | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

| IX. Information on your company | Yes | No | I don't know. |
|---|---|---|---|
| 1. Is there a written statement of policy on aviation safety? | 1 | 2 | 3 |
| 2. Is there a written airline safety program? | 1 | 2 | 3 |
| 3. Is there a written airline crisis management plan? | 1 | 2 | 3 |
| 4. Is there a language gap for receiving safety-related information? | 1 | 2 | 3 |

Please offer any suggestions or comments that you wish. ( If you prefer, you may answer in your native language.)

**Comments and Suggestions :**

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

**Thank you for your time !**

## APPENDIX D: Questionnaire for Asian CAA officials

**NO SAFETY, KNOW PAIN ! KNOW SAFETY, NO PAIN !**

# AIRLINES NEED YOUR HELP,

# WE NEED YOURS, TOO !

## Questionnaire

**Just several minutes** of your time could help complete this questionnaire which is part of a research study on **airline safety management**. You will receive a summary of the results if you tick the box below.

☐ Please send me a survey summary.

In answering the questions, please give your personal view, which may not necessarily reflect your organisation's "official view". **All information given will be treated as strictly confidential. Results of the survey will be counted only in an aggregate form so that neither organisations nor persons can be identified.**

Name (optional):

Position in your Organisation:

Working experience in Aviation : ☐ less than 2 years ☐ 2 - 5 years ☐ 6 - 10 years ☐ 11 - 15 years ☐ 16 - 20 years ☐ more than 20 years

Working background ☐ Pilot ☐ Air Traffic Officer ☐ Engineer ☐ Other

Country (optional):

**AVIATION SAFETY IS ----- A SHARED RESPONSIBILITY !**

**From your observation, please circle the number as appropriate to indicate your opinion on airlines in your country.**

| **I. Organisation structure** | **strongly disagree** | | | | | **strongly agree** | **I don't know** |
|---|---|---|---|---|---|---|---|
| 1. In the past several years, most airlines have undergone too fast expansion in the scale of its operations. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. Functional responsibility for safety in most airlines is clearly placed. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. The influence of safety staff in most airlines is strong. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. The position of safety manager or personnel in most airlines' hierarchy is appropriate. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

| **II Management styles** | **strongly disagree** | | | | | **strongly agree** | **I don't know** |
|---|---|---|---|---|---|---|---|
| 1. Most airlines' top management is dedicated to supporting safety policies and events. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. Most airlines' operations managers are strongly involved in the safety events. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. Most airlines' safety manager/personnel have direct access to top management. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. The safety inspection program in most airlines is satisfactory. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

| **III. Organisational climate** | **strongly disagree** | | | | | **strongly agree** | **I don't know** |
|---|---|---|---|---|---|---|---|
| 1. In general, the awareness of safety in most airlines is good | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. Channels for communication in most airlines are accessible. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. Flight and ground crews co-ordinate well in most airlines. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. Most airlines' policy encourages voluntary safety reports from flight/ground crews. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. Most airlines' crews are willing to report hazards/incidents. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

| **IV. Operational standards and training** | **strongly disagree** | | | | | **strongly agree** | **I don't know** |
|---|---|---|---|---|---|---|---|
| 1. Most airlines make strong efforts to standardise checklists and manuals in accordance with its policy. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. Most airlines' selection criteria for flight crews are high. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. Most airlines' quality of recurrent training is very good. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. Most airlines' human factors training is | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

effective.

PLEASE MAKE SURE YOU HAVE ANSWERED ALL THE QUESTIONS. THANK YOU !

| **VI. Indicate your opinion on the importance of the following to airline safety :** | **least important** | | | | | **most important** |
|---|---|---|---|---|---|---|
| 1. Top management | 1 | 2 | 3 | 4 | 5 | 6 |
| 2. Organisational structure | 1 | 2 | 3 | 4 | 5 | 6 |
| 3. Organisational climate | 1 | 2 | 3 | 4 | 5 | 6 |
| 4. Operational standards | 1 | 2 | 3 | 4 | 5 | 6 |
| 5. Training | 1 | 2 | 3 | 4 | 5 | 6 |
| 6. The role of Aviation Regulatory Authority | 1 | 2 | 3 | 4 | 5 | 6 |
| 7. Others (Please specify) | 1 | 2 | 3 | 4 | 5 | 6 |

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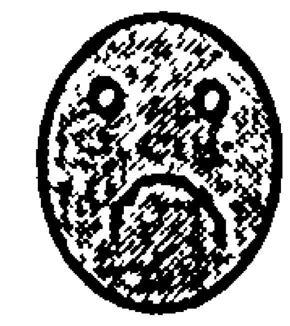
| **VIII. Self- evaluation of your organisation** | **strongly disagree** | | | | | **strongly Agree** | **I don't know** |
|---|---|---|---|---|---|---|---|
| 1. Its pace of response to technological change is good. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. Its follow-up to check compliance with its safety standards is strict. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. Its capacity to guide effectively the adequate training of airlines is good. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. It provides adequate safety information to airlines. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. Its investigators are independent and not influenced by the authorities during the accident/incident investigation. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 6. Its investigators are qualified to the level of advanced technology aircraft. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 7. It is necessary to set up an independent aircraft accident investigation agency in your country. | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

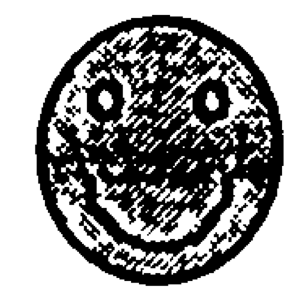
**Please offer any suggestions or comments on airline safety management that you wish. ( If you prefer, you may answer in your native language.)**

**Comments and Suggestions :**

**Thank you for your time !**

## APPENDIX E : Questionnaire for Taiwanese airline pilots

NO SAFETY, KNOW PAIN ! 

KNOW SAFETY, NO PAIN ! 

# 航 空 安 全 管 理 問 卷

多一分關心，則多一分安全。僅僅十分鐘，你就能協助我們完成這份問卷。它是一篇有關航空公司安全管理研究的一部分。如果你想要獲得一份結果摘要的話。請在下列方格內打 v

☐請寄給我一份研究摘要

請使用您個人觀點回答下列問題，並不需要表示公司的觀點。問卷結果將以整體作計算，不以個人或公司爲考量。您的意見，我們也將以機密保存。

姓名（如果您願意）________________

您在公司的職務________________

航空界工作經驗　☐少於2年　☐2-5年　☐6-10年　☐11-15年　☐16-20年　☐20年以上

飛行背景（如果您有的話）

☐ 軍方　☐ Ab-initia

航空公司（如果您願意）________________

請就下列問題圈選出你的看法：

## 一、公司組織結構：

| | 極不同意 | | 有些不同意 | 有些同意 | | 非常同意 | 不知道 |
|---|---|---|---|---|---|---|---|
| 1. 過去幾年，公司在航運規模上有顯著的成長。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. 公司對飛安的職責有明確的釐定。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. 公司的飛安人員具有足夠的影響力。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. 在公司的組織結構上，飛安室的編置適當。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

## 二、管理方式：

| | 極不同意 | | 有些不同意 | 有些同意 | | 非常同意 | 不知道 |
|---|---|---|---|---|---|---|---|
| 1. 高階管理高度支持各項飛安政策及活動。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. 航務處主管及訓練主管均關切並參與公司各項安全或意外事件的分析與調查。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. 飛安室主任或科員可與高階管理者直接溝通。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. 飛行獎賞制度完善。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. 公司內部飛安檢查方式令您滿意。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

## 三、組織文化：

| | 極不同意 | | 有些不同意 | 有些同意 | | 非常同意 | 不知道 |
|---|---|---|---|---|---|---|---|
| 1. 整體來說，公司上下對飛安的警覺程度良好。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. 公司上下的溝通管道良好。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. 公司空、地勤人員合作情況良好。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. 公司政策上鼓勵所有人員主動實施安全報告。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. 公司空、地勤人員都樂於主動報告飛行相關危險或意外事件。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

## 四、航務標準及訓練

| | 極不同意 | | 有些不同意 | 有些同意 | | 非常同意 | 不知道 |
|---|---|---|---|---|---|---|---|
| 1. 公司積極進行操作手冊及檢查卡的標準化。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. 公司的飛行員甄選標準很高。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. 公司的飛行複訓品質要求良好。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. 公司飛行員普遍對所飛機型經驗豐富。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. 公司在有關Human Factors 的訓練（包括CRM）足夠且有效。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

## 五、資源應用情況

| | 極不同意 | | 有些不同意 | 有些同意 | | 非常同意 | 不知道 |
|---|---|---|---|---|---|---|---|
| 1. 在任何相關飛機失事或意外後，公司在規定或操作程序上的修訂反應能力良好。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. 公司上下對航空界飛安相關資訊接收能力良好。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. 公司對意外或失事事件資料庫的建立與應用良好。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. 公司積極的參與國內外各項飛安組織、會議或研討會。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. 公司有效且經常的提供所有人員各項安全資訊。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

## 六、請您指出下列各點影響公司飛安的重要程度

| | 極不重要 | | 有點不重要 | 有點重要 | | 非常重要 |
|---|---|---|---|---|---|---|
| 1. 高階管理 | 1 | 2 | 3 | 4 | 5 | 6 |
| 2. 飛行訓練 | 1 | 2 | 3 | 4 | 5 | 6 |
| 3. 組織文化 | 1 | 2 | 3 | 4 | 5 | 6 |
| 4. 組織結構 | 1 | 2 | 3 | 4 | 5 | 6 |
| 5. 操作標準 | 1 | 2 | 3 | 4 | 5 | 6 |
| 6. 資源應用能力 | 1 | 2 | 3 | 4 | 5 | 6 |
| 7. 民航局角色 | 1 | 2 | 3 | 4 | 5 | 6 |

8. 其他（請說明）____________________

____________________

## 七、組織效益：

| | 極不同意 | | 有些不同意 | 有些同意 | | 非常同意 | 不知道 |
|---|---|---|---|---|---|---|---|
| 1. 公司在飛行安全上投資了許多。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. 公司的安全標準十分嚴格。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. 公司緊急狀況處理的能力良好。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. 公司以過去的飛安表現為榮。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. 公司在整體的服務形象上十分良好。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

## 八、民航局的角色：

| | 極不同意 | | 有些不同意 | 有些同意 | | 非常同意 | 不知道 |
|---|---|---|---|---|---|---|---|
| 1. 民航局的作爲能適當地配合各項民航科技的改變。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. 民航局對各項飛行標準的釐定十分明確。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. 民航局對航空公司各項訓練的指導能力良好。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. 民航局能適當的提供飛安資訊給各航空公司。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. 民航局擁有對高科技飛機失事調查的能力。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

## 九、公司有關資訊：

| | 有 | 沒有 | 不知道 |
|---|---|---|---|
| 1. 公司內有明確的書面飛安政策。 | 1 | 2 | 3 |
| 2. 公司內有書面的飛安計畫。 | 1 | 2 | 3 |
| 3. 公司內有危機處理手冊。 | 1 | 2 | 3 |
| 4. 公司在飛安相關資訊接收上，有語文上的障礙。 | 1 | 2 | 3 |

最後請您提供對公司安全管理的看法及改進建議（例如：政策、制度、訓練‧‧‧‧‧民航法規等。）

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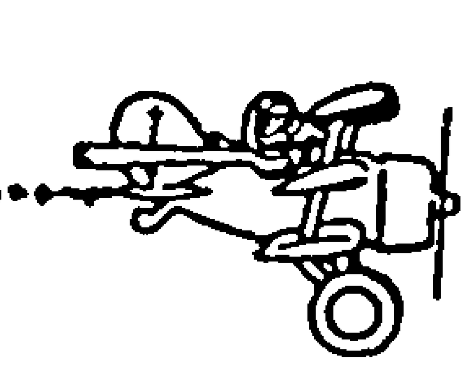
衷心地　謝謝您的協助！



## 八、民航局的角色：

| | 極不同意 | | 有些不同意 | 有些同意 | | 非常同意 | 不知道 |
|---|---|---|---|---|---|---|---|
| 1. 民航局的作爲能適當地配合各項民航科技的改變。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 2. 民航局對各項飛行標準的釐定十分明確。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 3. 民航局對航空公司各項訓練的指導能力良好。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 4. 民航局能適當的提供飛安資訊給各航空公司。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 5. 民航局擁有對高科技飛機失事調查的能力。 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |

## 九、公司有關資訊：

| | 有 | 沒有 | 不知道 |
|---|---|---|---|
| 1. 公司內有明確的書面飛安政策。 | 1 | 2 | 3 |
| 2. 公司內有書面的飛安計畫。 | 1 | 2 | 3 |
| 3. 公司內有危機處理手冊。 | 1 | 2 | 3 |
| 4. 公司在飛安相關資訊接收上，有語文上的障礙。 | 1 | 2 | 3 |

最後請您提供對公司安全管理的看法及改進建議（例如：政策、制度、訓練‧‧‧‧‧民航法規等。）

______________________________________________

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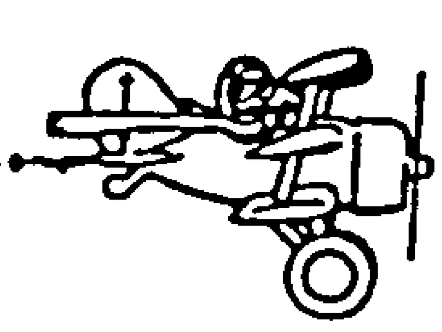
衷心地　謝謝您的協助！‧‧‧‧



# APPENDIX F : Interview Questions for Airline Pilots

## Survey Questions for Taiwanese Airline Pilots

**Demographics:**

Your position: ______ Captain ______ First Officer

Your flying background: ______ Military pilot ______ Ab-initio

How long have you worked for this company?

What aircraft type do you fly for your airline at present?

**Company management:**

What is the flight safety personnel's position in the company?

To whom does this/these personnel report?

Who in the company investigates accidents, incidents, deviations, and violations?

Does your company have a policy about pairing new Captains with new First Officers?

______ yes______ no

Does the company have a flight standards committee or designated flight standards personnel?

______ yes ______ no

**Pilot selection, training and operation standard:**

Does your airline impose minimum standards for:

New-hire pilot qualifications? yes_____ no______
Captain upgrade qualifications? yes_____ no______
Use of simulator? yes_____ no______
CRM training? yes_____ no______

What are the minimum qualifying standards for pilot employment in your company?

Are professional references requested and verified?

_____ yes _____ no _____ I don't know

Do you use contract flight training ?

______ yes______ no

When contract training is used, which types of training do you contract out?

Initial yes_____ no______
Recurrent yes_____ no______
Upgrade yes_____ no______
Transition yes_____ no______
Instructor/check pilot yes_____ no______

Does the company provide formal CRM training?

______ yes_ _____ no

When is CRM provided?

______ initial training ______ recurrent training
______ upgrade training ______ transition training

Who receives formal CRM training?

New-hires? yes_____ no______
Captain upgrade candidates? yes_____ no______

Is joint CRM training conducted with both cockpit crewmembers and flight attendants?

______ yes ______ no

Is LOFT training conducted?

______ yes ______ no

**Company resource management:**

Does your company have a formal incident reporting system? Please describe:

Will you voluntarily make an incident report?

______ yes ______ no ______ it depends

Is there an active accident prevention program?

______ yes ______ no

Who do you report to if you have something about safety event?

______ flight operation manager ______ chief pilot _____ flight safety staff

_____ others Why ?

Is there any flight safety or accident/incident database in your company?

______ yes ______ no ______ I don't know

**The role of CAA:**

Do you feel that your CAA inspectors are sufficiently familiar with the operation of your aircraft type?

______ yes ______ no

Do you think you can be assisted on flight training by the CAA?

______ yes ______ no

Do you think you can be assisted on safety by the CAA?

______ yes ______ no

Do you think it is necessary to contact the CAA concerning airline safety matters?

______ yes ______ no Why?

Do you agree that the contents of CAA's pilot licensing test are appropriate to the practical aviation environment?

____ absolutely agree ____ agree ____ disagree _______ absolutely disagree

Do you think that CAA should offer appropriate references and material for the licensing test?

______ yes ______ no

**Language communication gap:**

During your type/simulator training abroad, do you agree that the language gap influenced your learn speed?

____ absolutely agree ____ agree ____ disagree _______ absolutely disagree

During your type/simulator training abroad, have you ever experienced that due to the language gap you don't know how to ask the questions you had?

______ yes ______ no

Have you ever experienced that due to the language gap you misunderstood the meaning of the flight manual?

_____ yes _____ no

**Flying with expatriate crews:**

How does flying with expatriate (multinational) crews differ from flying with crewmembers of your own nationality? Is your performance changed by working with expatriate crews?

What is the best thing about flying with expatriate (multinational) crews?

What is the most frustrating thing about flying with expatriate (multinational) crews?

**Communication in the cockpit:**

What is your special communicaton experience in the cockpit due to initial training background?

What is your special communicaton experience in the cockpit due to crew position?

# Appendix G : Participating aviation regulatory authorities and Asain airlines

**Participating Aviation Regulatory Authorities:**

Civil Aviation Department, Hong Kong

Ministry of Transport, Japan

Civil Aviation Administration, Korea

Department of Civil Aviation, Malaysia

Air Transportation Office, Department of Transportation, Pilippines

Civil Aviation Authority, Singapore

Department of Aviation, Thailand

Civil Aeronautical Administration, Taiwan

**Participating Asian Airlines:**

| | | |
|---|---|---|
| All Nippon Airways, | Asiana Airlines, | Cathay Pacific, |
| Dragon Air, | Garuda Indonesia, | Japan Airlines, |
| Korean Air, | Malaysia Airlines, | Philippine Airlines, |
| Singapore Airlines, | Thai International, | Merpati Airlines, |

## APPENDIX H : Respondents' perception of important factors to airline safety

**Table H-1 Repeat Measures Analysis of Vatiance Summury Table of Perceived Important Factors to Airline Safety by Position and Initial Training Background of the Pilot (Taiwanese pilots)**

| Source of Variation | SS | DF | MS | F | Sig of F |
|---|---|---|---|---|---|
| Within cells | 874.32 | 1374 | .64 | | |
| Factors | 198.83 | 6 | 33.14 | 52.08 | .000 |
| Background by factor | 2.54 | 6 | .42 | .64 | .568 |
| Position by factor | 3.72 | 6 | .62 | .97 | .441 |
| Position by background by factor | 2.66 | 6 | .45 | .67 | ..565 |

**Table H-2 Post hoc t-test Paird Analysis of Perceived Important Factors to Airline Safety**

| Factors | Mean | No of cases | t value | DF | 2-tail probability |
|---|---|---|---|---|---|
| Top management | 5.52 | 233 | 5.56 | 232 | .000 |
| Training | 5.79 | 233 | | | |
| Top management | 5.52 | 233 | 11.88 | 232 | .000 |
| Organisational structure | 4.64 | 233 | | | |
| Top management | 5.52 | 233 | 7.09 | 232 | .000 |
| Organisational culture | 5.03 | 233 | | | |
| Top management | 5.52 | 233 | 3.45 | 232 | .001 |
| Operating standard | 5.72 | 233 | | | |
| Top management | 5.52 | 233 | 8.74 | 232 | .000 |
| Resource management | 4.80 | 233 | | | |
| Top management | 5.52 | 233 | 11.11 | 232 | .000 |
| The role of CAA | 4.34 | 233 | | | |
| Training | 5.79 | 233 | 17.53 | 232 | .000 |
| Organisational structure | 4.64 | 233 | | | |
| Training | 5.79 | 233 | 11.97 | 232 | .000 |
| Organisational culture | 5.03 | 233 | | | |
| Training | 5.79 | 233 | 2.45 | 232 | .015 |
| Operating standard | 5.72 | 233 | | | |
| Training | 5.79 | 233 | 14.15 | 232 | .000 |
| Resource management | 4.80 | 233 | | | |
| Training | 5.79 | 233 | 14.46 | 232 | .000 |
| The role of CAA | 4.34 | 233 | | | |

| Factors | Mean | No of cases | t value | DF | 2-tail probability |
|---|---|---|---|---|---|
| Organisational structure | 4.64 | 233 | 5.58 | 232 | .000 |
| Organisational culture | 5.03 | 233 | | | |
| Organisational structure | 4.64 | 233 | 15.66 | 232 | .000 |
| Operating standard | 5.72 | 233 | | | |
| Organisational structure | 4.64 | 233 | 2.66 | 232 | .008 |
| Resource management | 4.80 | 233 | | | |
| Organisational structure | 4.64 | 233 | 3.42 | 232 | .001 |
| The role of CAA | 4.34 | 233 | | | |
| Organisational culture | 5.03 | 233 | 11.15 | 232 | .000 |
| Operating standard | 5.72 | 233 | | | |
| Organisational culture | 5.03 | 233 | 3.01 | 232 | .003 |
| Resource management | 4.80 | 233 | | | |
| Organisational culture | 5.03 | 233 | 7.11 | 232 | .000 |
| The role of CAA | 4.34 | 233 | | | |
| Operating standard | 5.72 | 233 | 13.38 | 232 | .000 |
| Resource management | 4.80 | 233 | | | |
| Operating standard | 5.72 | 233 | 13.70 | 232 | .000 |
| The role of CAA | 4.34 | 233 | | | |
| Resource management | 4.80 | 233 | 5.95 | 232 | .000 |
| The role of CAA | 4.34 | 233 | | | |

**Table H-3 Repeat Measures Analysis of Vatiance Summury Table of Perceived Important Factors to Airline Safety (Asian pilots)**

| Source of Variation | SS | DF | MS | F | Sig of F |
|---|---|---|---|---|---|
| Within cells | 114.42 | 270 | .42 | | |
| Factors | 46.43 | 6 | 7.79 | 18.38 | .000 |

**Table H-4 Repeat Measures Analysis of Vatiance Summury Table of Perceived Important Factors to Airline Safety (Asian CAA officers)**

| Source of Variation | SS | DF | MS | F | Sig of F |
|---|---|---|---|---|---|
| Within cells | 36.61 | 1105 | .35 | | |
| Factors | 6.06 | 5 | 1.21 | 3.48 | .006 |

**APPENDIX I : Qualitative information gathered from the airline safety management survey**

The following comments of the postal questionnaires and interviews carried out with 32 airline pilots consists of an identification of the key themes mentioned by the interviewees. These themes are supported by quotes given by the pilots.

These areas are as follows:
Organisational structure, management style, organisational culture, operational standards and training, resource availability, language barriers, the role of CAA, and flying with expatriate pilots.

## 1. Organisational Structure

Any policy or regulation should consider its feasibility and acceptability, and it would rather be little and simple to ensure its effectiveness.

The Flight Safety Office or Department should be placed at a level higher than Flight Operations Department to ensure its neutrality. Safety-related personnel should be qualified and capable of practising their specialities without being restrained by the Flight Operations Department.

Safety-related personnel should be competent individuals with professional experience and credentials to ascertain and certify their fitness for their jobs.

The Flight Safety Office should be fitted in a position where it may override the other departments in the organisation structure.

The Flight Safety Office should include both flight and maintenance personnel.

## 2. Management Style

Basically the company knows the importance of safety, but sometimes top management just don't know how to apply it in the airline management system, resulting in a different perception towards safety.

Increasing employee's involvement and assimilation.

A basic application for top managers should be an open mind to new thoughts. Their personal subjective opinions should not be so strong so as to refuse to accept any other suggestions that are different from their own.

The extent of collaboration among departments determines an airline's safety performance.

Changing current severe punishment policy.

The major mission of our company is the pursuit of profit, so there are no budgets available to enhance flight safety.

Although our company has strict regulatory safety requirements, these requirements are not fully carried out in actual practice.

## 3. Organisational Culture

Each country should honour its own cultural traditions and characteristics, which not only helps constitute more pragmatic rules, easier operative codes, and more efficient regulations for itself, but also facilitates the integration of international safety knowledge and information.

Our company gives small reward and severe punishment.

Flight and ground crews do not co-operate well enough. When problems come up, they either cover them up or lay the blame on each other.

To both airlines and CAA, the constitution and operation of policies should be fair, reasonable and open. It is especially necessary to get rid of the burdens from the culture of Air Force. The hiring of personnel should be based on their competence for the job rather than an arrangement of reciprocal agreement.

Although aircrews may agree training on CRM, their thinking styles and personality are unlikely to completely co-operate with it. Besides, once an accident or incident occurs, ground crews tend to guess its causes by the pilot's performance and attitude on the ground rather than objectively judge the actual causes.

Overall safety depends not only on the efforts of pilots but on the support and assistance of flight attendants.

There should not be any disciplinary action taken on refusing to fly aircraft for safety reasons.

## 4. Operational Standards and Training

Flight engineers are reluctant to read abnormal and alternative procedure checklists from OPS manual.

Simulator programs should be LOFT orientated.

Operation procedures not only are not unified because everyone does not practise SOP, but also are altered to follow the standard of the one with highest rank.

The arrangement of flight schedule should be more humanised and not exceed pilots' workloads.

Our company has to clearly define 'Captains Authority' relating to safety items.

The top managers not only do not have aviation experience, but merely take into consideration how much money is going to be spent on training and running the system. Under the direction of laymen, the occurrence of accidents is not beyond expectation.

There is a lack of professional training on safety personnel and CAA safety officials as well.

Our company publicly recruits new employees to be trained abroad for 300 hours as first officers. The problem is that civil training is short of complete and effective flying training, and the 300-hour training are not enough to complete overall F/O training. During an emergency, they are apt to cause fatal accidents, which is something that needs to addressed.

Pilots should be encouraged to follow standard operation procedures.

Flight safety education to ground crews needs strengthening. Horizontal communication is necessary and should be promoted.

5. **Resource Availability**
I sincerely recommend top managers to focus their attention on dealing with the problems of flight and cargo operations. Especially when treating flight operations, never try to save little money and result in losing more money.

The safety staff just like to complete the investigation process as soon as possible, seldom try to do further action.

As learning from past accidents was almost impossible, how could leaning from past incidents be expected!

6. **The Role of CAA**

Civil Aviation Regulations should be revised and modified in time to meet up-to-date needs, and the emphasis should be placed on overall needs rather than specific requirements of a company. What is easily open to be criticised is the different interpretations to the same code.

Civil Aviation Regulations should be revised to meet current needs. ( x 2 )

Airport facilities, such as the navigation system, should be improved.

Civil Aviation Regulations should be continuously revised to cope with the requirements of modern civil aviation safety. ( x 2)

The CAA should have more budgets to enhance the salary of civil aviation officials, renew airport navigation facilities, and reinforce necessary training.

Expediting professional training for accident investigators.

The CAA officers are seriously incompetent in carrying out its surveillance and oversight functions. Professional training is needed for inspection staff.

CAA should assist Flight Control to renew its facilities and reinforce the training of flight control personnel.

Civil Aviation Regulations should be revised and updated.

7. **Language Barriers**
Crew often discuss technical problems in Mandarin, leaving the English-speaking captain out of the loop.

English reports and documentation regarding aviation safety need to be abstracted into Chinese in order to have its causation and corrective actions known to all the pilots in a short time.

Affiliated organisations, such as the CAA and airlines, should make the effort to translate foreign languages into Chinese to ensure understanding and effectiveness, because the language proficiency of most aviation personnel is not good enough to comprehend aviation-related reports and documentation written in languages other than Chinese.

Mastery of aviation English is the most important requirement. Safety managers here seldom place emphasis on it.

Foreign reports and documentation cannot be thoroughly understood due to lack of language gap. In addition, the safety policy in the airline is not clear enough, resulting in slow reaction to the change of international aviation standards.

Establishing an ad hoc translation unit to translate international safety information is needed to reach the purpose of unification.

8. **Flying with Expatriate Pilots**

- **Advantages:**

Less pressure is felt when I work with expatriate pilots. ( x 3 )

Expatriate pilots divide PF and PNF clearly, so when working with them, first officers can focus on PF and do their best. ( x 2 )

My performance will be better to fly with multi-national crew because I will feel more free to question captain's decisions and give more advice.

Though a language barrier exists, expatriate pilots are easier to communicate with. On the contrary, native pilots are more stubborn and have stronger hierarchical concept.

It is more relaxing to work with them, and I fly better.

I can pay less attention on socialising with the crew and working on crew co-ordination more.

Native pilots tend to be more authoritative and harder to communicate with. Native pilots value cockpit ethics, but expatriate pilots value co-operation.

The majority of native pilots will treat us like the second auto pilot and train us like trained pilots. I will be more aggressive when flying with multi-national crews, but definitely not with our own national crews.

It is better to fly with foreign pilots. They have more knowledge that we can learn from, and they follow SOP precisely.

The cockpit atmosphere is more open and comfortable when flying with a foreign captain. You can make your decision freely and discuss with the captain reasonably. The native captain will use what he calls experience by himself to disregard all decisions you make. Sometimes, you wonder what he knows about aviation except flying the aircraft.

Expatriate pilots explain clearly during takeoff and landing. They value crew co-operation to complete each mission.

Easy to communicate. They follow standard procedures and regulations.

They value communication. CRM concept is better. Flying knowledge is better.

They fully follow the SOP and FCOM. If they have a different view, they will raise the question and seek advice and discussion.

Expatriate pilots value first officers' responsibilities. They respect our viewpoints. Thus, our performance improves and confidence is consequently built up.

They have more professional knowledge, and their operations fully follow standard procedures and regulations.

Really listen to each other. Less poker faces. They are more patient when working with others.

Working with them is simpler because they seldom talk about personal topics.

Expatriate pilots are more willing to share their knowledge and experience with other crew members.

You can learn surprisingly different ways of doing things. You can mirror your culture against other cultures and see the weak point of your own culture.

I must be extremely clear with my communications with regard to the other crew members.

- **Disadvantages:**

**Language barrier**

During long haul flight, it often seems that no topics of conversation are found except talking about flying the airplane. Long haul flight is boring. (x3)

People from different countries will try harder to communicate with each other.

Because I am not able to express opinions freely in English, language communication is limited to flying, and there is no chance to get to know each other more. The language barrier seems to distance us.

The English accent of those who come from non-English speaking countries is not easily understood.

I need to listen carefully when I converse with expatriate pilots with strong accent.

We'll try to speak out and let them know what we are going to do and how we shall co-ordinate in the cockpit.

Expatriate pilots speak too fast to understand, especially at the first contact.

Due to the language barrier, it is difficult to get along well with them. Not always understanding fully.

It is better to use plain English in the cockpit than slang.

I must be extremely clear in my communications with regard to the other crew members.

My performance may be decreased. There was more communication between crew members because of language barriers.

**Racial discrimination**

Racial discrimination and cultural gaps between east and west mostly come from "X" crews. Generally, "XX" crews are more understanding and easier to work with.

Some expatriate pilots have inexplicable sense of superiority: they rebuke other aircrews due to language problems.

Language barrier causes the difficulty to form close friendship with them. (x3)

Due to communication problems, we talk less in the cockpit.

It takes time to understand their operations and attitudes. It is necessary to use different expressions to avoid misunderstanding.

Language, social, cultural barriers. Military mentality which deters good CRM.

Misunderstanding with specific regard. Synergy is lacking.

Crew communication must be emphasised strongly to cockpit management. In other words, SOP and FCOM (Flight Crew Operation Manual) must be fully understood to maintain the effectiveness and safety of flight.

**Communication in emergency**

Failure to recognise deterioration flight, weather or system problems which will cause bigger problems or a later emergency situation.( x4 )

I have a much higher sense of awareness of all switch positions, aircraft configuration and clearances to prevent problems due to misunderstanding or lack of proficiency on system knowledge.

**Different background and life style**

A few misbehaving pilots like to put the blame on bad communication to cover up their own misconduct.

You receive a diverse view of ideas and operational procedures based on different backgrounds.

Some expatriate pilots still adopt the operational procedures of their previous airlines.

Expatriate pilots still follow the previous company's policy on operation. Some expatriate pilots do not know the company's regulations.

Expatriate pilots care less about the company's policy, and that easily causes misunderstanding. Besides, they seldom participate in group activities.

Misunderstandings happen due to different culture.

It is not about the problem of language. It is about the way they talk, which is very different from what natives are used to.

It looks like they are doing summer jobs rather than their careers. He kept on asking me whether I would like to share coffee with him.

It is difficult to understand their personalities due to language and culture problems.

They have crew concept, but no company concept.

Due to different background, it takes time to communicate. I do not understand their jokes.

**Others**
To all appearances native pilots work harmoniously together.

I have to be and learn to be very abstemious.

Expatriate pilots like to fly manually, which adds to the workload.
The authority should continuously assist airlines to locate their shortcomings and improve them.

Airlines consider commercial benefits more than aviation safety, so it is necessary for CAA to reinforce inspection to balance each other.

Insurance companies can play a more effective role in promoting aviation safety. They can access each airline's safety management program to estimate the amounts of premiums and maximum recovered payment.

More safety-related information is needed. Language is a problem.

Because the standard of operation and training in the airlines is set up based on the documentation of aircraft manufacturers, the provision of adequate manuals to meet the needs of a variety of people all over the world should be encouraged.

## APPENDIX J: Questionnaire for the feasbility study of implementing a confidentiality aviation incident reporting program in Taiwan ( airline pilot survey )

Dear Sir/Madam,

The confidential aviation incident reporting systems have been running for many years in many countries, such as CHIRP in the UK, ASRS in the USA, CASRP in Canada, and CAIR in Australia. All of them have made great contributions to improve their air safety.

By distributing this questionnaire to you, I would like to know your opinions about the feasibility of setting up a confidential aviation incident reporting system in Taiwan in the next two or three years.

Such a system would be an independent agency which will provide guarantee of confidentiality and immunity to the reporter, channels for sharing flying and safety experience, information to prevent human errors from happening again, and chances to improve the system's effectiveness.

All information given will be treated strictly confidential. I will appreciate if I can contact you by phone should I require additional information. If possible, please leave your phone number and address as well as the dates and time convenient for contact on the second page of the questionnaire.

Your opinions will be the most important treasure in this feasibility study. I do hope you can spend a little time to fill out the three-page questionnaire. After reading the attached references, would you please complete the questionniare and place it in the self-stamped envelop enclosed and return it to me. Thank you for your co-operation.

Wish you a pleasant and safe flight.

Hero Ho
Research Associate
Department of Air Transport

Enclosure: 1. ROCARE questionnaire
2. Three cases of CHIRP, ASRS reports
3. Brief introduction of CHIRP, ASRS, CASRP, and CAIR.
4. Translated research paper with the title of "Hurry Up Syndrome"
5. Draft of propaganda leaflet of ROCARE

# AVIATION INCIDENT REPORTING SYSTEM QUESTIONNAIRE

**( A possible Taiwanese Confidential Aviation Incident Reporting System: ROCARE)**

**"A uniform with four rings on the sleeve and 20,000 flying hours do not make us immune from these human limitations."**

**The ROCARE system is designed to improve aviation safety and help you, we need to know what your expectation is.**

**Name (optional):** ______________________________

**Position in your organisation:** ☐ Captain ☐First Officer ☐ Other

**(Please specify)** ______________________

**Working experience in Airlines:** ☐ less than 2 years ☐ 2 - 5 years ☐ 6 - 10 years ☐ 11 - 15 years ☐ more than 15 years

**Flying background:** ☐ Military ☐ Ab-initio ☐ Other

**(Please specify)** ______________________

**Airlines (optional):** ______________________________

**1. Are you willing to share your flying or safety experience with others?**
☐ Yes ☐ No ☐ I don't know

**2. Do you encourage others to share their flying or safety experience?**
☐ Yes ☐ No ☐ I don't know

**3. Have you ever voluntarily reported flight incidents or hazard events?**
☐ Yes ☐ No ☐ I don't know

**4. Under the current situation in Taiwan, do you think it is possible for pilots to voluntarily report and share pilot performance incidents?**
☐ Absolutely possible ☐ Possible ☐ Impossible ☐ Absolutely impossible

**5. Have you heard of any foreign voluntary aviation incident reporting system, such as CHIRP in the UK or ASRS in the USA?**
☐ Yes ☐ No

**6. Have you ever read any research papers or reports from aviation incident reporting systems?**
☐ Yes (Please go to No 7) ☐ No (Please go to No 8)

7. **If so, are these papers or reports written in ...?**
☐ **Chinese** ☐ **English**

8. **Do you think such reporting systems will help to improve aviation safety?**
☐ **Absolutely agree** ☐ **Agree** ☐ **Disagree** ☐ **Absolutely disagree**

9. **If the incident report-receiving agency is an independent aviation authority /organisation, which provides guarantee of confidentiality and immunity to the reporter, will you voluntarily make an incident report?**
☐ **Absolutely agree** ☐ **Agree** ☐ **It depends** ☐ **Disagree** ☐ **Absolutely disagree**

10. **If the confidential reporting system is established in Taiwan, which do you think is the best agency to administer the system?**
☐ **ALPA** ☐ **FSF** ☐ **School**
☐ **CAA** ☐ **MOT** ☐
**Research institute**
☐ **Other (Please specify)** ______________________________

11. **If the confidential reporting system is established in Taiwan, what are the possible reasons that might result in your unwillingness to make an incident report?**
☐ **Too much time on paper work** ☐ **Company might not want us to report**
☐ **Distrust the confidentiality** ☐ **Might cause negative consequences**
☐ **Don't think it will help to improve safety** ☐ **Lose face**
☐ **Don't know what ROCARE can do** ☐ **ROCARE personnel are not professional**
☐ **I am not sure what can be reported** ☐ **Fear of punitive action**
☐ **Other (Please specify)**
______________________________

12. **If an appropriate agency is chosen, to what degrees do you trust that the agency can provide confidentiality to the reporter?**
☐ **Absolutely trustful** ☐ **Trustful** ☐ **Distrustful** ☐ **Absolutely distrustful**

13. **If an independent incident report-receiving agency is appropriately chosen, confidentiality and immunity to the reporter is also guaranteed, do you think it is feasible to implement ROCARE in the next two years?**
☐ **Absolutely feasible** ☐ **Feasible** ☐ **No comments** ☐ **Not feasible**
☐ **Absolutely not feasible**

14. **To what extent do you think the confidential reporting system is needed in Taiwan?**
☐ **Absolutely necessary** ☐ **Necessary** ☐ **Unnecessary** ☐ **Absolutely unnecessary**

**Please briefly comment the reasons you think why your colleagues are not willing to report aviation incidents or hazards:**

______________________________

______________________________

______________________________

**Please offer any additional comments or suggetions to ROCARE in the space below:**

**Please turn to the third page. Thank you !**

# INTERNET SAFETY WEB

*"Through a better channel of sharing information, we can continue our progress on aviation safety. "*

**Computer has been the inevitable third pilot in our flight cockpit. It not only flies with us but also providesus with a lot of global information. In the near future, you can use your personal computer at home and easily gain aviation safety information all over the world. The following questions are designed to know what you think of transferring aviation safety information from the Internet.**

**1. Do you have your own personal computer?**
**☐ Yes (Please go to No 2) ☐ No (Please go to No 4)**

**2. How often do you use computer at home?**
**☐ Always ☐Sometimes ☐Occasionally ☐ Never**

**3. Is your personal computer connected to the Internet?**
**☐ Yes ☐ No ☐ I don't know**

**4. Is it possible for you to purchase your own personal computer in the next two years?**
**☐ Yes ☐ No ☐ I don't know**

**5. Are you willing to recieve safety and its related information through computer?**
**☐ Absolutely willing ☐ Willing ☐ Unwilling ☐ Absolutely unwilling**

**6. Are you willing to offer your flying experience or safety suggestions on the Internet?**
**☐ Willing ☐ It depends ☐ Unwilling**

**Thank you very much for your assistance. Wish you a nice and safe flight!**

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Department of Air Transport

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敬愛的教官：

您好！「航空危險事件主動報告系統」在部分國家實施多年，諸如美國的 ASRP 、 加拿大的 CASRP 、澳洲的 CAIR 等，多具成效，個人將透過這項問卷，希望能獲得您對這項系統——————一個國家級中立、保証機密、不處罰、經驗分享、避免人為錯誤及改善組織效能的報告系統，在臺灣未來二、三年可行性的一般看法。

您的問卷，將以機密處理。個人可能對部分問卷作進一步的電話訪問。如果您願意，是否能請您在問卷第二頁寫下您的電話、地址及方便聯絡日期及時間。

衷心地期望您能花少許時間，在閱讀附件後，賜予對建立這項系統的意見，這也將是這項研究最有價值的部分，請您將「問卷」放置在附上之「自黏回郵信封」內寄回即可，謝謝。

謹此　　　敬祝您

飛行愉快平安

英國克蘭菲爾大學
航空運輸管理系

何立己

敬上

附件：一 問卷

二 飛安報告英美三案例

三 各國飛安報告系統基本資料表

四 中華民國飛安報告系統宣傳小卡草案

Professor Rigas Doganis
Head of Department
Direct dial +44 (0) 234 754742

# 飛安報告系統ROCARE問卷

「一位擁有20年，上萬飛行小時的飛行員，也無法避免人類本身的限制及可能犯錯。」

「飛安報告系統」是為了提升飛行安全及您的需要而設計，因此我們想要知道您對它有多少的期望。

姓　　　　名：（如果您願意）：＿＿＿＿＿＿＿＿＿＿

飛　行　職　務：☐Captain ☐First Officer ☐其他，請註明＿＿＿

航空公司工作經驗：☐少於2年　☐2－5年　☐6－10年
☐11－15年　☐15年以上

飛　行　背　景：☐軍方　☐Ab-initio　☐其他

航空公司(如果您願意)：＿＿＿＿＿＿＿＿＿＿

一、您是否願意與別人分享您的飛行或飛安經驗。

☐願意　☐不願意　☐不知道

二、您是否鼓勵別人分享他的飛行或飛安經驗。

☐鼓勵　☐不鼓勵　☐不知道

三、您曾經主動報告飛行意外或危險事件嗎？

☐曾經　☐從來沒有　☐不知道

四、在現有的國內環境，您認為飛行員可能主動分享或報告飛行危險事件嗎？

☐絕對可能　☐可能　☐不可能　☐絕不可能

五、您是否曾聽說過國外的航空危險事件志願報告系統，諸如美國的ASRS 、英國的 CHIRP 等。

☐有　☐沒有

六、您是否閱讀過，經由航空危險事件志願報告系統的報告，所作出研究或報導。

☐有，請回答第七題　☐沒有，請跳出至第八題

七、如果有的話，請問是：

☐中文刊物　☐英文刊物

八、您認為此項報告系統或其研究報告，對飛行安全改善有幫助嗎？

☐極有幫助　☐有幫助　☐沒有幫助　☐絕無幫助

九、如果國內民航界在一獨立可信的機構下，成立這項系統，您會願意報告嗎？（假設有立法保證個人保密及報告人或當事人絕對不會受罰或後續影響）

☐極願意　☐願意　☐視情況　☐不願意　☐絕不願意

十、假設國內成立此系統，您認爲可能最佳的實施單位：（可複選）

☐飛行員協會　☐飛安基金會　☐學校

☐民航局　☐交通部　☐學術機構

☐其他，請註明

十一、假設報告系統成立，您可能不願意報告的原因是：（可圈選多項）

☐可能花太多時間紙上作業　☐公司可能不鼓勵報告

☐不相信立法個人保密維護功能有效　☐可能產生後續麻煩

☐不認爲會產生安全改善功能　☐報告系統人員專業能力不足

☐我不知道此系統能作什麼　☐沒面子

☐我不確定什麼情況可以報告　☐可能受到處罰

☐其他，請註明

十二、假使選擇了一個適當的機構，您對個人報告保密維護的相信程度

☐絕對相信　☐相信　☐不相信　☐絕不相信

十三、以國內目前的航空環境，假設在有立法「個人保密」及「絕不處罰」的條件下，又選擇了一個適當的機構主持。這項「飛安報告系統」(ROCARE)在未來二、三年內的可行性是：

☐高度可行　☐可行　☐沒意見　☐不可行　☐絕不可行

十四、您個人認爲此系統在臺灣實施的需要程度：

☐極需要　☐需要　☐不需要　☐絕不需要

十五、歡迎您賜予我們對「飛安報告系統」(ROCARE)的任何意見或建議：

________________________________________

________________________________________

________________________________________

衷心地謝謝您的協助，祝您飛行愉快平安！

---

您的大名：____________ 電話：____________(O)____________(H)

方便連絡日期及時間：____________________

電腦已成爲我們座艙中不可或缺的第三位飛行員。它不但在天上與我們共同飛行，地上也可以提供我們許多全球的資訊。不久的未來，您在家中的電腦，將可輕易簡便的獲得全球的航空安全資訊。以下問題，是想知道您對飛安相關訊透過電腦網路傳遞的看法：

一、您目前擁有個人電腦嗎？

□有，請回答第二題　□沒有，請跳至第四題。

二、您目前在家使用電腦嗎？

□經常　□偶而　□極少　□沒有

三、您家中的電腦有接上網路嗎？

□有　□沒有　□不知道

四、您近二年可能購買個人電腦(PC)嗎？

□可能　□不可能　□不知道

五、您是否透過電腦接收各項飛安相關資訊？

□極願意　□願意　□不願意　□絕不願意

六、您願意在電腦網路上，表達您的飛行經驗或飛安建議嗎？

□願意　□視情況　□不願意

# 飛安報告英美三案例

何立己

前兩案例，取材自英國國防研究中心主持之「機密人爲因素意外報告系統(CHIRP)」出版之Feedback刊物。第三案例，取材自美國NASA主持飛行安全報告系統(ASRS)出版之Callback刊物。

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案例一：

機長正操作著飛機。以下是我們的機內及無線電通話。

機　長：我將會在50浬的Romeo點開始下降。

副機師：Yes, Captain.

副機師：要不要我向開曼度機場塔台詢問最新資料？

機　長：Yes.

機　長：下降檢查。

……………………………。

副機師：Captain, VOR DME消失了。

機　長：別緊張，我正在使用Doppler DME。

副機師：Captain，可是………它並沒有許可在進場時使用。

機　長：拜託！別緊張。這個機場我已經飛了二十年，我們以前還飛到機場上方，作幾個迴旋大角度下降，就落地了呢！

副機師：Captain,但是我們已經低於最低航線高度(MEA)了，而且我想是前面的山擋住了VOR的DME？

機　長：不是，你太多心了。

副機師：開曼度塔台，請你確定一下你的VOR DME是否運作正常？

塔　台：Affirmative，工作正常。你們許可進場。

副機師：Roger，我們飛機上的兩個VOR DME都出現了紅旗。

塔　台：我確定VOR運作正常。

副機師：Captain，我很確定我們高度低了，前方的山使得我們收不到VOR DME的信號。

機　長：不對。

副機師：Captain,我實在很擔心…………。

機　長：……………………………………。

副機師：（我目視著座艙外，看見了山前面的河，當時我心中很確定，我們飛行的高度低了，而且正朝著前面的山而飛。）

機　長：……………………………………。

副機師：Captain，我可不可以拜託您爬高，落地後你要做什麼都可以。

機　長：……………………………………。

副機師：重飛油門（我推上了四個油門）。

副機師：Captain，請您立即爬高至13,500呎。

機　長：（機長沒說一句話，即按我的建議立即執行）

副機師：（我們在雲上11,500呎時，看到了山就在我們正前方不遠處。）

後來我們繼續進場，也因為我們爬高後，VOR DME接收正常。落地後，機長對我說，謝謝並表示道歉。因此，我個人認為當一位副機師面臨生命、工作或執照的選擇時，從飛行生涯的長期觀點來看，我建議選擇生命及做他應該做的抉擇。

*　*　*　*

案例二：

我們以三萬七千呎高度通過阿爾卑斯山，當時我是波音727的副機師。那天晚上飛行一切正常，我們正準備通過山區。之後，我們遭遇了輕度亂流，後來愈來愈嚴重。由於逐漸增強的亂流，我的機長態度也隨之改變，以下是後來發生的片斷。

機　長：我最討厭亂流了。

副機師：我也是。

機　長：請求航管改變我們的飛行高度。

副機師：日內瓦…………因為亂流，請求改變飛高度。

機　長：Roger．…………下降至高度三萬三千呎。

（在這同時，亂流已增強至中度，機長收回油門始下降，這時候飛機機頭始上仰，滾轉或側滑，你能想出飛機能飛出什麼姿態，就是那個姿態。我不知道這是因為亂流，還是飛行員因為緊張而造成的。然而，重要的是在三萬三千呎高度時，機長收回了油門，而飛機姿態卻在20度的仰角

，以下是我們的對話。）

副機師：飛機姿態。Pitch! Pitch!

機　長：OK。　　　　（機長將飛機姿態調整至向下15度。這時候，飛機由於速度太大，MNO bell開始響起。）

副機師：速度！

機　長：OK。（接下來他把飛機姿態操作至向上20度仰角，用來減速，而油門仍在慢車的位置，當時的高度三萬一千呎。

副機師：Captain，請留意飛機姿態，要不飛機可能就要失速了。………狀態、狀態。加油門，要不然就失速了。

機　長：別叫了。

副機師：Captain，如果你加上油門，我就不叫了。

機　長：OK。（機長加上了油門，飛機操作回正常的姿態）

接下來的飛行至落地。我們幾乎都沒有說話，特別是我。我想讓大家知道的是：如果當時是在阿爾卑斯山上空三萬一千呎失速，我不認爲有我們機會改正回來。

*　　*　　*　　*

以上兩份報告分別代表了在組員溝通、協調上的問題。當我們以白紙黑字寫下這兩件事時，我們似乎覺得它是幾乎不可能發生的。但問題是在即使飛行員進入了座艙，再優秀的飛行員也還是人，也還是會犯錯。在日常生活中，飛行員總是有一份驕傲，一點點跟別人不一樣。或許我們可以從以下四項因素來瞭解座艙組員的關係：個性、資深程度、操作能力及接收能力。舉個例子來說：如果一位極資深又具權勢性格的訓練機師，當他在操作飛機時，如果他的副機師是一個個性溫順又資淺的新進飛行員的話，不論在西方或東方，公司或國家文化背景不同，這位副機師通常是不會去建議或懷疑他的機長判斷的。幾年前，加拿大即有一個失事案例。副機師在作進場各項檢查時，機長並沒有作任何反應，他也不敢詢問及糾正他，因爲他知道，機長當天的心情並不好。而事實上，機長在飛機進場階段時，即已死於突發的心臟病。飛機就因爲這樣，在沒有任何人操作下，撞及地球而失事。我們可以想像出來，如果前面兩個案例，沒有副機師積極表現的話，可能會發生什麼後果。

權威性格的機長與溫順個性的副機師配對飛行並不是飛行座艙

內的單一現象或問題。當我們閱讀過去的飛機失事的案例或從你自己的飛行經驗中，我們都可以瞭解使兩位機長同一座艙時，可能也會產生問題，機長相互間通常是不會去表達或甚而刻意去隱藏，他對另一位機長操作狀況判斷不同的意見，因爲他不願意去質疑同儕的能力或讓他沒面子。

我們似乎可以想想或自我詢問，在座艙內飛行，特別是機長是否應該把那份驕傲隱藏起來，而表現出我知道的可能有限，我可能會犯錯，我樂於接受建議。現代民航機飛行訓練有許多的改變，其中之一就是不再是個人飛行，而是一個團隊飛行(Flight crews)的觀念。不論如何，當你在飛行的時候，遇有任何疑問，建議儘速表達出來，從安全的角度而言，至少你還有再飛行的機會吧！

*　　*　　*　　*

案例三：

「Cleared for the transition」將可能造成你進入危險的狀態。根據美國航空安全報告系統所獲得各項報告中，有關航管人員與飛行員通話的過程，最常產生誤解的一句話就是：

「Cleared for the transition許可轉換（高度）」

當航管人員發出此項許可時，他通常不會包括指示的高度，因爲他期望飛行員會遵照他上次指示的高度。往往在這同時，飛行員在獲得許可轉換高度後，可能上升或下降至飛行穿降圖程序上所建議的高度。在1993年ASRS所收到的一份報告中，即清楚地描寫了這項誤解所產生的結果。

「……VOR 進場過中， 我獲得了中心的無線電許可通知”TA002, Cleared for the transition”，在我覆誦領知後，開始下降。我在上一次獲得的指示高度是8000呎……而穿降圖上的轉換高度是4500呎。在下降的過程中，中心的通話一直非常的忙碌，在我通過8000呎時，我並沒有通知報告。但我下降通過7000呎的時候，中心通知我說：你應該保持8000呎高度，但現在保持7000呎好了。我回答說：Roger，許可保持7000呎，但不久之前我才被許可下降至轉換高度的。中心立即補充說：「對啊你獲得的是許可轉換高度，但你仍然要保持高度8000呎啊！」接下來，我並沒有繼續爭議……。

〃Cleared for the transition〃並不是航管通話的標準詞彙，我想許可的正確表達應該是〃 許可下降並保持 8000 呎 (Cleared to descend and maintain 8,000)〃。穿降圖上的轉換高度是提供給飛行員在萬一無法連絡上航管時的建議高度。」

誠如飛行員報告所述，飛行資料手冊(AIM)上並沒有明確的定義〃Cleared for the transtion〃，使得飛行員極易產生誤解。而航管人員在發出這句話許可時，也忽略了再補充一句許可的高度，才使得飛行員可能過早爬高或下降。ASRS 建議最佳的方式是航管人員能順道再重述原來的指示高度，將可能預防上述的誤解或避免可能造成的意外或失事。

＊　＊　＊　＊

請教您下列兩個問題：

問題一：如果您是案例一或二的副機師，您會願意向機長表達出您的意見嗎？不論願意或不願意，如果平安落地後，您願意分享您的經驗給別人並填寫報告嗎？（假設我們也成立一個國家級且具有保障之〃飛安報告系統〃）爲什麼？

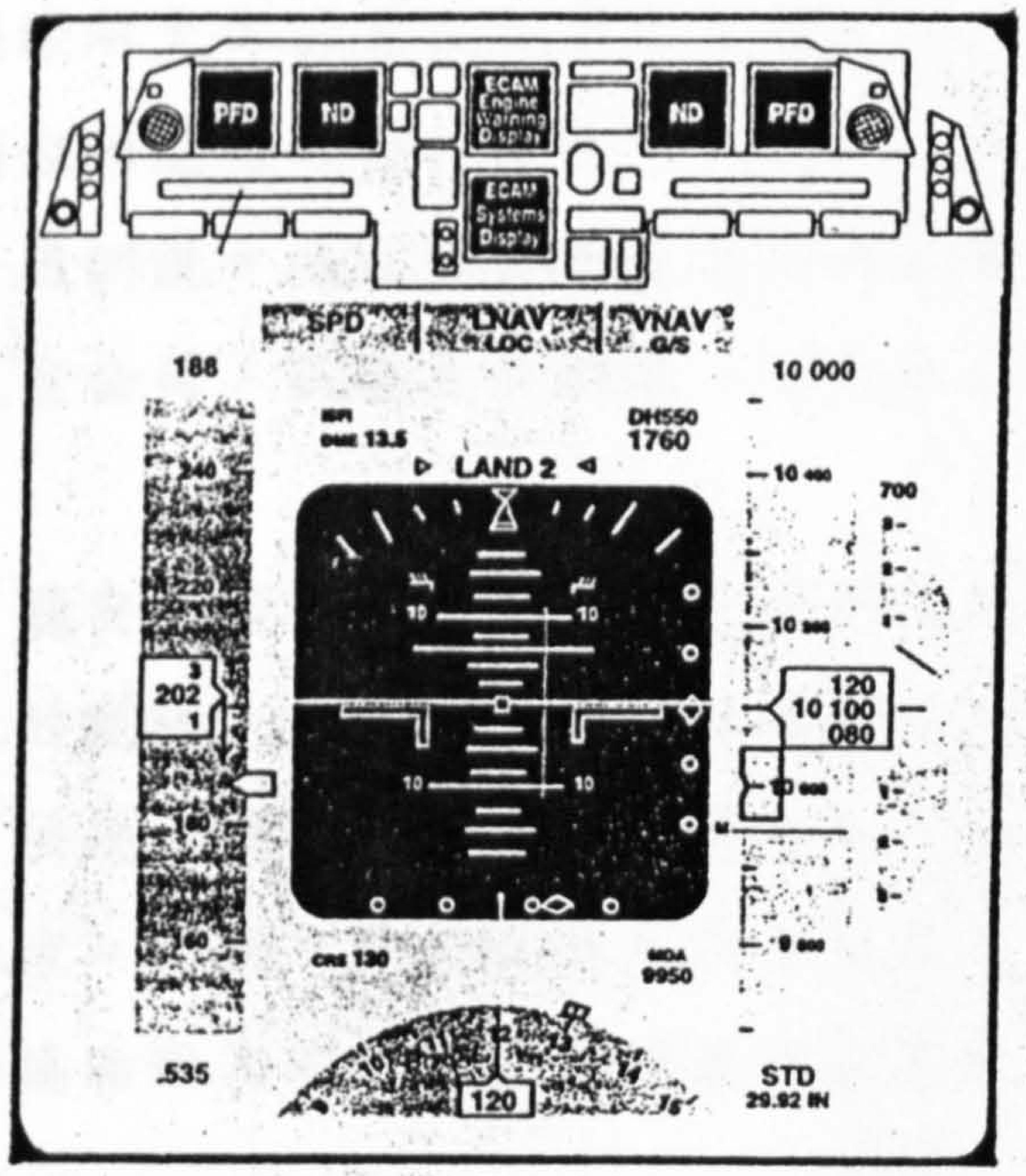
問題二：如果您是案例一或二的機長，您會包容或接受副機師的建議及如此的表達方式嗎？飛行落地，您可能道歉嗎？願意填寫報告分享經驗嗎？爲什麼？

草案

# 中華民國飛安報告系統

# ROC Voluntary Aviation Safety Reporting System

# ROCARE




分享飛安經驗

關心飛行安全

# 中華民國飛安報告系統

## ROC Voluntary Aviation Safety Reporting System

近二十年來的民航界飛機重大的失事，有百分七十以上是由於人爲因素所造成。經由研究事調查發現，我們瞭解大部份重大失事發生以前，大都曾經當發生過類似的危險或意外事件，祇是未造成較大傷害而已。若我們說，飛行員是飛行安全的最後一道防線，那麼航空公司、民航立法機關，則是最大的最後一道防線。

「飛安報告系統」的目的是希望透過各項危險事件資訊的獲得，辨識出在我們的環境中，有關飛機、設施、法規、飛行訓練或管理等各項可能危害飛行安全的地方。同時，透過較深入的系統及人爲錯誤分析，進而協助改善飛行環境及避免他人再發生同樣的錯誤。

飛安報告系統(ROCARE)————是一個完全中立的嶄新飛安系統。它的功能是搜集各項飛行危險相關資訊，分析它，並使用分析結果來協助航空界改善飛安、維護生命及財產。祇要與民航界有相關的任何人

，都歡迎您提出報告，我們都將以絕對機密處理，不致造成您自己或其他個人的任何傷害或影響。

「飛安報告統」(ROCARE)是一個主動自願的報告系統，歡迎您提供我們下列資訊：

- ■任何有關民航的缺失。有那些應改善？
- ■預見的危險。可能那兒有問題？
- ■任何非民航局強制報告之危險或意外事件。如何及可能爲什麼發生了錯誤？

再一次說明，「飛安報告系統」是一個中立且保證個人機密的系統，您的報告或建議絕對不會導致個人或其他個人受到影響或傷害。附上之報告表及免郵資信封，竭誠地歡迎您，當您發現任何影響飛安的情況時，請您填寫它。

報告表的上半部是有關個人資料部份，請您填寫它，以便我們的分析人員在需要其他或進一步資訊時與您連絡。接下來，我們會立即將報告表的上半部個人資料部份撕下寄還給您。我們將不保留任何您的個人資料，您的報告即成爲不具名之報告資料。

「飛安報告系統」就如同其他民航機構一樣，主

要目的是促進飛行安全。您的各項問題或觀點，我們都將由專業人員研討後，轉送給民航相關機關或航空公司參考。我們亦將定期的將各項寶貴的經驗、資訊或問題，在我們的飛安刊物上刊出或討論。

如果您對刊物有興趣，也請您讓我們知道您的大名及地址。

「飛安報告系統」是一個中立且實務導向的研究小組，將陸續與美國、英國、加拿大、澳洲、德國等國相關機構保持密切合作，整合經驗，分享資訊。「飛安報告系統」也將與國際上其他安全研究機構及失事調查組織建立交流網，以提供國內及您個人更多的安全資訊。

**Your name:** ______________________ **Telephone:** **(Office)** ____________ **(Home)** ____________

**Dates and Time available to be contacted:** ______________________________

## APPENDIX K : Questionnaire for the feasbility study of implementing a confidentiality aviation incident reporting program in Taiwan ( air traffic controller survey )

Dear Sir,

The confidential aviation incident reporting systems have been running for many years in many countries, such as CHIRP in the UK, ASRS in the USA, CASRP in Canada, and CAIR in Australia. All of them have made great contributions to improve their air safety.

By distributing this questionnaire to you, I would like to know your opinions about the feasibility of setting up a confidential aviation incident reporting system in Taiwan in the next two or three years.

Such a system would be an independent agency which will provide guarantee of confidentiality and immunity to the reporter, channels for sharing flying and safety experience, information to prevent human errors from happening again, and chances to improve the system's effectiveness.

All information given will be treated strictly confidential. I will appreciate if I can contact you by phone should I require additional information. If possible, please leave your phone number and address as well as the dates and time convenient for contact on the second page of the questionnaire.

Your opinions will be the most important treasure in this feasibility study. I do hope you can spend a little time to fill out the three-page questionnaire. After reading the attached references, would you please complete the questionniare and place it in the self-stamped envelop enclosed and return it to me.

Thank you for your co-operation.

Hero Ho
Research Associate
Department of Air Transport

Enclosure: 1. ROCARE questionnaire
2. Three cases of CHIRP, ASRS reports
3. Brief introduction of CHIRP, ASRS, CASRP, and CAIR.
4. Translated research paper with the title of "Hurry Up Syndrome"
5. Draft of propaganda leaflet of ROCARE

# AVIATION INCIDENT REPORTING SYSTEM QUESTIONNAIRE

**( A possible Taiwanese Confidential Aviation Incident Reporting System: ROCARE)**

**The ROCARE system is designed to improve aviation safety and help you, we need to know what your expectation is.**

**Name (optional):**

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**Position in your organisation:** ☐ Senior or Supervisor ☐ Air Traffic Controller ☐ Assistance Air Traffic Controller ☐ Other

(Please specify) ____________________

**Working experience in Air Traffic Control:** ☐ less than 2 year ☐ 2 - 5 years ☐ 6 - 10 years ☐ 11 - 15 years ☐ more than 15 years

**Original training background:** ☐ Military ☐ Other

**Unit:** ☐ Tower ☐ Area Control ☐ Approach Control

1. **Are you willing to share your safety experience with others?**
   ☐ Yes ☐ No ☐ I don't know

2. **Do you encourage others to share their safety experience?**
   ☐ Yes ☐ No ☐ I don't know

3. **Have you ever voluntarily reported aviation safety related incidents or hazard events?**
   ☐ Yes ☐ No ☐ I don't know

4. **Under the current situation in your organisation, do you think it is possible for you to voluntarily report human performance related incidents?**
   ☐ Absolutely possible ☐ Possible ☐ Impossible ☐ Absolutely impossible

5. **Have you heard of any foreign voluntary aviation incident reporting system, such as CHIRP in the UK or ASRS in the USA?**
   ☐ Yes ☐ No

6. **Have you ever read any research papers or reports from aviation incident reporting systems?**

☐ Yes (Please go to No 7) ☐ No (Please go to No 8)

7. If so, are these papers or reports written in ...?
☐ Chinese ☐ English

8. Do you think such reporting systems will help to improve aviation safety?
☐ Absolutely agree ☐ Agree ☐ Disagree ☐ Absolutely disagree

9. If the incident report-receiving agency is an independent aviation authority /organisation, which provides guarantee of confidentiality and immunity to the reporter, will you voluntarily make an incident report?
☐ Absolutely agree ☐ Agree ☐ It depends ☐ Disagree ☐ Absolutely disagree

10. If the confidential reporting system is established in Taiwan, which do you think is the best agency to administer the system?
☐ FSF ☐ School ☐ CAA ☐ MOT
☐ Research institute ☐ ALPA
☐ Other (Please specify) ______________________________

11. If the confidential reporting system is established in Taiwan, what are the possible reasons that might result in your unwillingness to make an incident report?
☐ Too much time on paper work ☐ Organisation might not want us to report
☐ Distrust the confidentiality ☐ Might cause negative consequences
☐ Don't think it will help to improve safety ☐ ROCARE personnel are not professional
☐ Don't know what ROCARE can do ☐ Lose face
☐ I am not sure what can be reported ☐ Fear of punitive action
☐ Other (Please specify)
______________________________

12. If an appropriate agency is chosen, to what degrees do you trust that the agency can provide confidentiality to the reporter?
☐ Absolutely trustful ☐ Trustful ☐ Distrustful ☐ Absolutely distrustful

13. If an independent incident report-receiving agency is appropriately chosen, confidentiality and immunity to the reporter is also guaranteed, do you think it is feasible to implement ROCARE in the next two years?
☐ Absolutely feasible ☐ Feasible ☐ No comments ☐ Not feasible
☐ Absolutely not feasible

14. To what extent do you think the confidential reporting system is needed in Taiwan?
☐ Absolutely necessary ☐ Necessary ☐ Unnecessary ☐ Absolutely unnecessary

15. Please briefly comment the reasons you think why your colleagues are not willing to report aviation incidents or hazards:

______________________________

**Please offer any additional comments or suggetions to ROCARE in the space below:**

**Please turn to the third page. Thank you !**

# INTERNET SAFETY WEB

*"Through a better channel of sharing information, we can continue our progress on aviation safety. "*

**Computer has been the inevitable third pilot in our flight cockpit. It not only flies with us but also providesus with a lot of global information. In the near future, you can use your personal computer at home and easily gain aviation safety information all over the world. The following questions are designed to know what you think of transferring aviation safety information from the Internet.**

**1. Do you have your own personal computer?**
☐ Yes (Please go to No 2) ☐ No (Please go to No 4)

**2. How often do you use computer at home?**
☐ Always ☐Sometimes ☐Occasionally ☐ Never

**3. Is your personal computer connected to the Internet?**
☐ Yes ☐ No ☐ I don't know

**4. Is it possible for you to purchase your own personal computer in the next two years?**
☐ Yes ☐ No ☐ I don't know

**5. Are you willing to recieve safety and its related information through computer?**
☐ Absolutely willing ☐ Willing ☐ Unwilling ☐ Absolutely unwilling

**6. Are you willing to offer your flying experience or safety suggestions on the Internet?**
☐ Willing ☐ It depends ☐ Unwilling

**Thank you very much for your assistance!**

**APPENDIX L : Qualitative information collected from the questionnaire**

( A survey for a possible Taiwanese confidential aviation incident reporting system)

The following analysis of the survey consists of an identification of the key themes mentioned by the questionnaires. These themes are supported by quotes given by the pilots and air traffic controllers.

These areas are as follows:

1. **Positive**

   It should be widely propagated in order to build up consensus.

   The confidential reporting system should be set up immediately. The receiving agency should produce and distribute a regular publication to the aviation community. ( x 3 )

   Confidential procedures need to be kept strictly scrupulous.

   The confidential reporting system is absolutely in need, but it should not become the security of the military or a cover-up of the hypocrite.

   A propagating manual is recommended to be published as reference material and distributed to all the personnel in the field.

   Military and civil air traffic controls do not co-operate well enough. Hopefully, the system can find a solution to the problem.

   It is worth trying. ( x 6 )

   I strongly agree to set up the system. However, its effects might not be as good as expected because of custom and practice.

   Immunity and confidentiality should be guaranteed. ( x 5 )

   First of all, the agency should take an example of a successful system to propagate its advantages. ( x 3 )

   Flight safety courses should be employed to propagate the system. The acquisition of top management's support is also important.

   The system is needed in our country. It would be better if more models can be provided.

   To senior flight or maintenance personnel, the confidential reporting system has a function of vigilance. Whereas to junior personnel, it gives them an education and offers them information of accumulative experience.

   The system allows us to report what used to be unspoken and unattended matters of flight safety.

   Besides immunity and confidentiality, why not add 'reward' for a worthy report? ( x 2 )

   The concept of incident reporting should be gradually introduced through stages of initial, transition, and recurrent training.

2. **Negative**

- **Confidentiality:**

  Many people seem too curious to let anything pass unnoticed, and are apt to spread incorrect news.

  If confidentiality is not kept strictly, reporters will be like the informants of the police.

  Absolute neutrality and confidentiality are needed. ( x 3 )

- **Objectivity:**

  The idea seems very grand, but there may be a deviation when it is put into practice.

  There is no adequate receiving agency.

  Political factors should be eliminated to ensure absolute professionalism.

  Based on past experience, it is unlikely to make amendments of aviation regulations in two years.

  Receiving agency should not hire personnel with military background in order to avoid problems of rank.

  Current regulations need to be improved.

  I don't know if there is a non-military background, independent, and trustful research institute.

- **Consequence:**

  It may influence the assessment of individual performance.

  It is impossible to get rid of follow-up trouble, such as revenge from the person being reported.

  I will agree only if it is possible to report anonymously. ( x 2 )

  We always discuss incidents in private.

  Never let CAA use the channel to carry out special inspections rather than assist improvement.

  Sorry, I am a junior first officer. I cannot afford to be a martyr. ( x 3 )

  Fear of ostracising by other crew members.

- **Others:**

  I doubt whether CAA encourages or supports the establishment of the confidential reporting program.

  The situation of military-trained pilots and the support of the company should be considered.

  Reporting should not involve a great deal of paperwork. The agency should also give reporters the convenience to place verbal reports.

It depends on the support of top management in the airlines and CAA. ( x 2 )

The system's staff should be professionals who understand the regulations of ICAO, the CAA- Taiwan and other aviation authorities.

Its success depends on the teamwork of the CAA, airlines, and pilots.

Building up the senses of assimilation and trust.

Please design a complete and simple reporting form.

Your instruction paper is very worth reading. I hope we can read more of this kind of paper and examples.

Building up a sense of trust between CAA and airlines.

## APPENDIX M1 and M2

# Appendix M1:
## The possibility for Repondents to Voluntarily report human performance incidents

QA4 possible to report incidents?

| Value Label | Value | Frequency | Percent | Valid Percent | Cum Percent |
|---|---|---|---|---|---|
| absolutely possible | 1 | 6 | 2.8 | 2.8 | 2.8 |
| possible | 2 | 48 | 22.7 | 22.7 | 25.6 |
| impossible | 3 | 147 | 69.7 | 69.7 | 95.3 |
| absolutely possible | 4 | 10 | 4.7 | 4.7 | 100.0 |
| | Total | 211 | 100.0 | 100.0 | |

Valid cases 211 Missing cases 0

QA4 possible to report incidents? by WORKEXP working experience in aviation

WORKEXP Page 1 of 1

| QA4 | Count / Exp Val / Row Pct / Col Pct / Tot Pct | less than 2 year 1 | 2-5 years 2 | 6-10 years 3 | 11-15 years 4 | more than 15 yea 5 | Row Total |
|---|---|---|---|---|---|---|---|
| 1 possible | Count | 6 | 15 | 23 | 4 | 6 | 54 |
| | Exp Val | 10.0 | 19.2 | 19.5 | 2.8 | 2.6 | 25.6% |
| | Row Pct | 11.1% | 27.8% | 42.6% | 7.4% | 11.1% | |
| | Col Pct | 15.4% | 20.0% | 30.3% | 36.4% | 60.0% | |
| | Tot Pct | 2.8% | 7.1% | 10.9% | 1.9% | 2.8% | |
| 2 impossible | Count | 33 | 60 | 53 | 7 | 4 | 157 |
| | Exp Val | 29.0 | 55.8 | 56.5 | 8.2 | 7.4 | 74.4% |
| | Row Pct | 21.0% | 38.2% | 33.8% | 4.5% | 2.5% | |
| | Col Pct | 84.6% | 80.0% | 69.7% | 63.6% | 40.0% | |
| | Tot Pct | 15.6% | 28.4% | 25.1% | 3.3% | 1.9% | |
| Column Total | | 39 | 75 | 76 | 11 | 10 | 211 |
| | | 18.5% | 35.5% | 36.0% | 5.2% | 4.7% | 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Pearson | 11.12365 | 4 | .02521 |
| Likelihood Ratio | 10.39649 | 4 | .03425 |
| Mantel-Haenszel test for linear association | 10.10790 | 1 | .00148 |

Number of Missing Observations: 0

---

QA4 possible to report incidents?

| Value Label | Value | Frequency | Percent | Valid Percent | Cum Percent |
|---|---|---|---|---|---|
| absolutely possible | 1 | 1 | 1.5 | 1.5 | 1.5 |
| possible | 2 | 27 | 39.7 | 40.3 | 41.8 |
| impossible | 3 | 37 | 54.4 | 55.2 | 97.0 |
| absolutely possible | 4 | 2 | 2.9 | 3.0 | 100.0 |
| | . | 1 | 1.5 | Missing | |
| | Total | 68 | 100.0 | 100.0 | |

Valid cases 67 Missing cases 1

QA4 possible to report incidents? by WORKEXP working experience in ATC

WORKEXP

Count

| QA4 | Count / Exp Val / Row Pct / Col Pct / Tot Pct | less than 2 years 1 | 2-5 years 2 | 6-10 years 3 | 11-15 years 4 | more than 15 years 5 | Row Total |
|---|---|---|---|---|---|---|---|
| 1 possible | Count | 0 | 2 | 9 | 8 | 9 | 28 |
| | Exp Val | 1.7 | 5.4 | 9.2 | 6.7 | 5.0 | 41.8% |
| | Row Pct | .0% | 7.1% | 32.1% | 28.6% | 32.1% | |
| | Col Pct | .0% | 15.4% | 40.9% | 50.0% | 75.0% | |
| | Tot Pct | .0% | 3.0% | 13.4% | 11.9% | 13.4% | |
| 2 impossible | Count | 4 | 11 | 13 | 8 | 3 | 39 |
| | Exp Val | 2.3 | 7.6 | 12.8 | 9.3 | 7.0 | 58.2% |
| | Row Pct | 10.3% | 28.2% | 33.3% | 20.5% | 7.7% | |
| | Col Pct | 100.0% | 84.6% | 59.1% | 50.0% | 25.0% | |
| | Tot Pct | 6.0% | 16.4% | 19.4% | 11.9% | 4.5% | |
| Column Total | | 4 | 13 | 22 | 16 | 12 | 67 |
| | | 6.0% | 19.4% | 32.8% | 23.9% | 17.9% | 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Pearson | 12.48870 | 4 | .01406 |
| Likelihood Ratio | 14.46126 | 4 | .00596 |
| Mantel-Haenszel test for linear association | 11.92086 | 1 | .00056 |

Number of Missing Observations: 1

# Appendix M2:
## The extent of trust to the potential receiving

QA12 do you trust it provide confidentiality?

| Value Label | Value | Frequency | Percent | Valid Percent | Cum Percent |
|---|---|---|---|---|---|
| absolutely trustful | 1 | 12 | 5.7 | 5.7 | 5.7 |
| trustful | 2 | 111 | 52.6 | 53.1 | 58.9 |
| distrustful | 3 | 83 | 39.3 | 39.7 | 98.6 |
| absolutely distrustf | 4 | 3 | 1.4 | 1.4 | 100.0 |
| | . | 2 | .9 | Missing | |
| | Total | 211 | 100.0 | 100.0 | |

Valid cases 209 Missing cases 2

QA12 do you trust it provide confidentiality?
by WORKEXP working experience in aviation

| QA12 | Count / Exp Val / Row Pct / Col Pct / Tot Pct | WORKEXP: less than 2 years (1) | 2-5 years (2) | 6-10 years (3) | 11-15 years (4) | more than 15 years (5) | Row Total |
|---|---|---|---|---|---|---|---|
| 1 trustful | Count | 23 | 38 | 42 | 11 | 9 | 123 |
| | Exp Val | 23.0 | 43.6 | 44.1 | 6.5 | 5.9 | 58.9% |
| | Row Pct | 18.7% | 30.9% | 34.1% | 8.9% | 7.3% | |
| | Col Pct | 59.0% | 51.4% | 56.0% | 100.0% | 90.0% | |
| | Tot Pct | 11.0% | 18.2% | 20.1% | 5.3% | 4.3% | |
| 2 distrustful | Count | 16 | 36 | 33 | 0 | 1 | 86 |
| | Exp Val | 16.0 | 30.4 | 30.9 | 4.5 | 4.1 | 41.1% |
| | Row Pct | 18.6% | 41.9% | 38.4% | .0% | 1.2% | |
| | Col Pct | 41.0% | 48.6% | 44.0% | .0% | 10.0% | |
| | Tot Pct | 7.7% | 17.2% | 15.8% | .0% | .5% | |
| Column Total | | 39 | 74 | 75 | 11 | 10 | 209 |
| | | 18.7% | 35.4% | 35.9% | 5.3% | 4.8% | 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Pearson | 13.66861 | 4 | .00843 |
| Likelihood Ratio | 18.42554 | 4 | .00102 |
| Mantel-Haenszel test for linear association | 5.11948 | 1 | .02366 |

Number of Missing Observations: 2