ANALYSIS OF AIRLINE HAZARDS AND RISKS

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Keiji Habara

Airline industry, typical high risk taking business, has faced severe management environment in recent years. As the first step of aviation risk management, the nature of aviation risks were clarified through the assessment of true hazards of aircraft operators. Advanced technology aircraft have been promoted the convenience and efficiency by automation and computerization, whereas they have created the environment to introduce another risks. Unsafe means inefficient. Efficiency consists of safety and technical progress.

I. Introduction

Accident Prevention Manual on air transportation was published by International Civil Aviation Organization (ICAO) in August 1984(1). According to its contents, it may be said that although essential matters and significant suggestions were pointed out, most of them have already been discussed and there are few distinguished innovative measures for safety management practiced among Japanese airlines at present. However, in practice, these safety measures have not always been taken effectively.

Air transport industry fundamentally requires risk management to cope with the nature of its activity and environment. Therefore, in fact, air transportation business is forced to promote safety level, to conduct risk management, and to facilitate accident prevention activities sufficiently. The reason is that air transportation is the typical highest risk bearing business and also aircraft operation is basically subject to expose much more hazards than surface transportation modes.

In addition, airline companies have particularly faced the drastic change of business environment in recent years. For example, serious competitive condition in the international market influenced by airline deregulation movement, the rise in fuel and labour cost, the considerable cost of purchasing aircraft and equipment, instability of the revenue of air carrier resulting from fluctuation of foreign currency exchange as well as unstable economic and political situation in the world.

Some of airline accidents will be compensated by the aviation insurance system, but the rest of them have to be managed to handle through risk management techniques other than insurance.

The management environment of air carrier as high risk taking company is as follows:

(1) under changeable weather conditions
(2) operation of aircraft on a large or world-wide scale
(3) regulatory requirments of periodical check and maintenance adjustment for the aircraft in service after the lapse of certain time
(4) lack of available aircraft in the airport because of above (3) resulting in not only delay but suspension of service

Conquering the hazards above mentioned through risk prevention, risk bearing, and risk transfer methods, even though imperfectly. Airlines have developed and grown so far with the improvement of safety standards of aircraft operation. According to ICAO manual(2), it is certain that the number of passenger fatalities per 100 million passenger kilometers in scheduled airline operations since 1960 shows a remarkable improvement in safety. Scheduled airline operations are much safer today from the passenger's point of view. However, during the period 1975–1980, the fatality rate has levelled off, suggesting that the limits of the traditional and regulatory safety methods may be needed to further reduce the accident rate(3).

If the air transport accident rate remains static, and the volume of air transport continues to grow, the number of accidents will involve, directly or indirectly, more and more people and the associated financial costs will rise proportionately(4).

It has been recognized that now is the time when safety management should be reviewed and improved accident analysis and prevention activities are required. Aviation authorities of many States have been fully aware that risk management programmes should be developed and more thorough accident analysis and prevention measures are needed.

In such a period of time, Japan Air Line Boeing 747 SR crashed because of the destruction of empennage in 1985 and 520 people were killed as the worst single aircraft accident in aviation history. The problem lies in that Boeing 747 had had no fatalities caused by mechanical failure except natural causes or and equipment, instability of the revenue of air carrier resulting from fluctuation of foreign currency exchange as well as unstable economic and political situation in the world.

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Observing the facts described above, I have been thinking that I may apply risk management theory to the management of air transport industry. Therefore, the purpose of this paper is to try to analyze the hazards and risks of airlines firstly in order to establish the basic concept of aviation risk management in airline.

II. The fundamental characteristics of aviation hazards

Hazards involved in aircraft are so variable and complex that it is necessary to examine the hazards inherent in aircraft. To sum up, the nature of aviation hazards may be generally characterized as follows:

(1) The impossibility of stoppage in the air and the restriction of flight activities

The aircraft is the transportation conveyance that cannot stop completely nor move back in the air, nor fly permanently. Accordingly there are the restrictions below.

1) Keeping of a necessary minimum speed

Aircraft have to keep a certain speed without fail in order to fly.

2) Restrictions of air space

There is the restriction of area on the airway. It is necessary to fly within the defined route area and impossible to land the field but the runway, maintaining a stipulated distance between the earth and other airplanes.

3) Limitation of flying time

There is an absolute time limitation because of impossibility of flying more than the loaded fuel. Thus, the time to judge the situation is very important factor in every phase of flight.

(2) The dependence of operation on meteorological conditions

Since aircraft is easily influenced by the weather conditions such as air turbulance, wind, fog, thunder, rain snow, ice, and stream, operation service is subject to them. Aircraft travel so swiftly that the operations needs the detailed and spot information on rapid changing weather around the area of air route. Current technology for forecasting weather cannot predict exactly in the small flying area to deal with sudden change of weather conditions. Although comfort is required significantly as the characteristics of air transport, the environments in which aircraft fly are under the very severe circumstances.

(3) Complexity and subtleness of operating procedures

1) Uunstable condition during landing and taking off

Since aircraft at take-off and landing tends to be unstable at the speed close to stall, much more sophisticated operations are needed than the other phases of flight. Factors impeding flight operations concentrating on these phases will increase the work load of cockpit crew.

2) A high possibility of losing the sence of sight of pilots

Unusual visual sensation that may take place during flight operation can lead to more dangerous effect than on the ground, because most of important information for pilots are got through eyes. Namely, when hallucination, parallax, optical illusion, perception gaps, or vertigo occurs, there is a strong possibility of these phenomena causing major accidents.

3) Necessity to recognize the situation correctly and secure information quickly

The operation of aircraft requires an instantaneous accurate judgement to meet the rapid change of situation because of the high speed.

(4) Potential fragility of airframe structure

Aircraft is not designed and manufactured with more than necessary strength to lose weight as much as possible for the purpose of promoting the flight performance. Especially, civil commercial aircraft cannot be produced so strong as military ones because the economic and financial factors should be taken into consideration. Therefore, civil commercial aircraft always have incompatibility in the relation not only between weight and structural strength but also between speed and stability in design and production.

(5) Difficulty of identifying potential risks

Aviation technology innovation is so rapid that man's ability cannot keep abreast of it and the development of new technology will always bring unforeseen risks. There is a high probability that unexperienced and unknown risks will arise, for unpredictable occurances on the ground will happen under flying circumstances in the air. Consequently, aircraft, especially new types, involve ultrahazardous variables. Air transportation industry continues to grow including potential and unpredictable risks. It takes a certain time to identify and assess the full risks of modern equipment such as automated and computerized system.

III. Real aspect of aviation accidents and risks

Owing to the advanced technology of aircraft and the development of avionics, aeronautical navigation aids, improved precision, reliability, and the effect of fail-safe features, it seems that accident rate have decreased gradually and safety records have remarkably increased. However, this trend may be due to the facts that the greater productivity of airlines as the result of the relative reduction of the number of hazardous take-offs and landings, and the enlargement of long range flight at one time. Thus, it cannot necessarily be said that safety technology has made a great progress(6).

Based on the analysis data of the accidents relative to crew(7), after the third generation aircraft (B-747, DC-10, L-1011) were introduced from the beginning of 1970's, the total number of fatalities of passengers have not decreased to a considerable degree. Compared the third generation aircraft with the second generation aircraft (B-727, B-737, DC-9), the former is 1.7 times the number of the latter in the fatality accident and also 2.4 times the number of the latter in the substantial or destroyed accident. Most of the third generation aircraft are equipped with automated cockpit. Therefore, the third must have less work load than the second, but latest aircraft have had much higher accident rate. On total loss accident, the rate has improved from per 20 or 30 thousand hours to per 80 thousand hours. Aviation accidents may be caused by the complication of various factors. The causes of aircraft accidents are mostly based on not so much machine as human factors.

From the late 1960's to 1970's, the reversion in the causes of accidents took place between the failure of machine as hardware and human factors as software. 76 percent of examined accident causes is attributed to crew, and only 12 percent is the failure of machine and incomplete maintenance(8). On the phase of accidents, firstly is approach and landing (55.4%), secondly is take-off and initial climb (20.6%)(9). The number of air collision is small now but tends to grow with increasing volume of air traffic. From the view point of accident prevention, it is important to dissolve the problems on human factors and accidents during the time of take-off and landing. Different innovative measures are developed and in process of practical use for the purpose of achieving this task.

FAA proposed that the aim of raising safety records for scheduled airlines is to improve fatality accident rates from 10^{-5} to 10^{-9}.

It is definitely necessary to review accident statistics in order to evaluate and analyse risks or safety in air transportation, but careful examination is needed to deal with statistical data on air safety record. There are such various ways of compiling data about aviation accident rates that the fundamentals of the sources of materials, relations, reasonableness, and fact-findings should be confirmed and considered with great care. Many accident statistics are of little value without providing no valid means of comparison.

Safety level of modern aircraft may be measured in terms of quantitative method and scientific theory to some degree, but risks cannot be necessarily be grasped inclusively and objectively. Also, past safety record cannot be the index to accident prevention in future. It is difficult to provide for the minimum standards as how safe is safe enough or it is impossible to get complete measurement as what is how risky. Finally, there remains no alternative but to rely on the judgement through subjective identification of risk. Since the safety level is changing according to age and technology, it is a serious question how to decide the levels of safety in relation between airline management and its operating capacity.

In the part of hardware, the measurement of safety is capable of being identified by quantitative method, but in the actual operation, it will be a very difficult decision making because a variety of qualitative factors should be taken into account.

IV. Conclusion

As aircraft accidents are characterized by the total loss of hull and the tragedies of mass fatalities, public attention is drawn to the large scale of disaster. Furthermore, it is clear that aircraft accidents still continue to happen at a certain rate even though accident rates fluctuate each year.

Under the same circumstances to which airlines all over the world are exposed when the safety record is decreasing, there must be had management somewhere in the corporate organization, so that exhaustive reconsideration should be claimed. The responsibility of safety and accident prevention dedefinitely rest with the management.

Once a fatal accident occurs, the effect of airline is often incalculable. Damages, unexpected cost, and loss of profit that will be huge amount might result in the failure of the company. In concluding, from the point of risk control, it is essential to think out how to invest aircraft, facilities, and personnel sufficiently. For the airline as common carrier which cannot survive without operation's safety, the investment to safety finally make corporate foundation fixed so as to maintain and promote social reliability.

Accident prevention cost have to be brought about through streamlined management, because it is difficult to shift this cost to air fare immediately. It should be noted that maintaining high levels of safety has nothing to do with the scale of capital. Rather, management attitude and corporate philosophy is significant factor.

(Associate Professor of Commerce)

Notes

(1) *Accident Prevention Manual* (Doc 9422-AN/923) First Edition-1984, International Civil Aviation Organization. (ICAO *Manual*)

(2) *Ibid.* p. 3.

(3) See pp. 41—43.

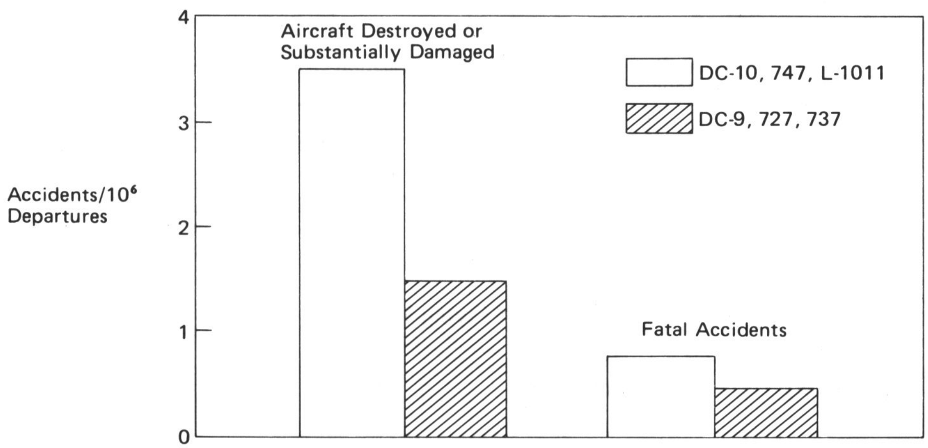
(4) *Ibid.* p. 44.

(5) Harry Hopkins, "747 15 years in line service," *Flight International,* 19 January 1985, pp. 28-30.

(6) J. M. Ramsden, The Safe Airline (London: Macdonald and Jane's Publishers Ltd., 1978), p. 16.

(7) Comparison of accidents relative to crew.

DC-10, 747, L-1011 versus DC-9, 727, 737



(World Airline Accident Summary 1/72-12/80)

(8) Primary cause of total hull loss accident

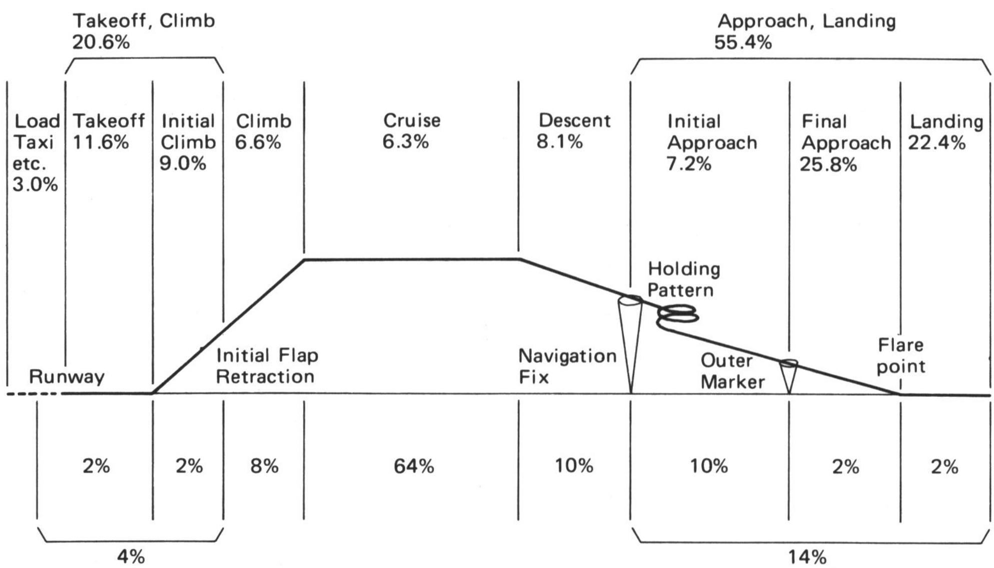
Primary factor	No. of accidents	P.C. of accidents (%)
Flight crew	185	76
Airplane*—	25	10
Maintenance	4	2
Weather	15	6
ATC	9	4
Misc (Other)	5	2
Total with known causes	243	100
Unknown or awaiting reports	60	
Total	303	

* — Flight control 28%
— Landing gear 28%
— Engine 16%
— Instrument 16%

(*Flight Safety* No. 44, December 1985)

(9) World Jet Fleet — All Types of Accidents — All operations (1959—1982)

Percent of Accidents

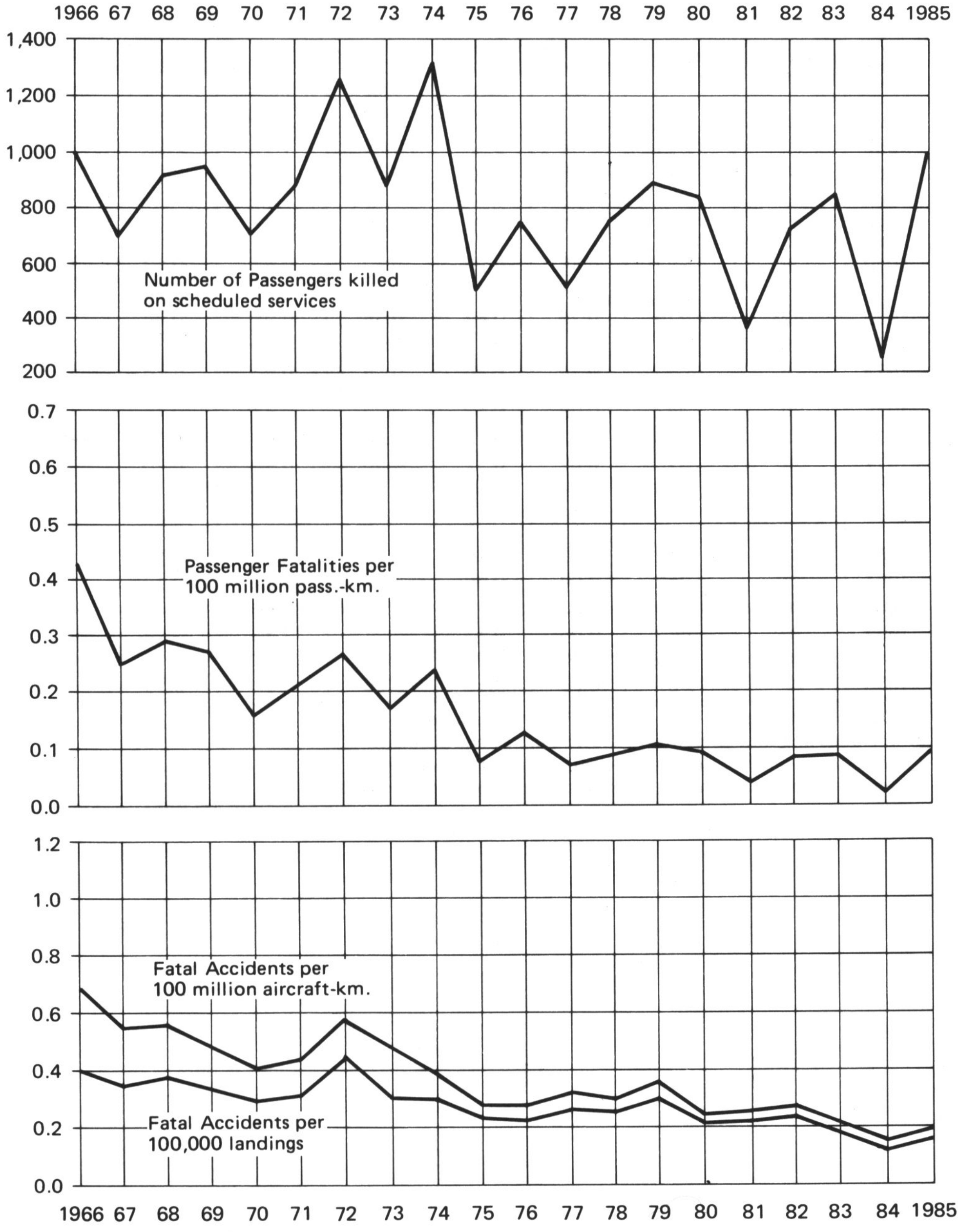


Percent of Flying Time

Excludes:
· Sabotage
· Military Action
· Turbulence Injury
· Evacuation Injury

(*Flight Safety* No. 44, December 1985)

(3) Fatal accident rates for passengers on world scheduled services, 1966–1985
(Rates refer to traffic of ICAO Contracting States, excluding the USSR)



(ICAO Bulletin, June 1986)

(3) Aircraft accidents involving passenger fatalities on scheduled air services, 1966–1985[1]
(1985 data are preliminary estimates)

Year	Aircraft accidents	Passengers killed	Passenger fatalities per 100 million		Fatal accidents			
					per 100 million		per 100,000	
			Pass.-km	Pass.-mile	Km flown	Miles flown	Aircraft hours	Aircraft landings
1966	31[2]	1,001	0.44	0.70	0.69	1.11	0.33	0.40
1967	30	678	0.25	0.40	0.57	0.91	0.29	0.35
1968	35	912	0.29	0.46	0.57	0.92	0.31	0.38
1969	32	946	0.27	0.43	0.48	0.77	0.27	0.34
1970	28	687	0.18	0.29	0.40	0.64	0.23	0.30
1971	31	867	0.21	0.34	0.44	0.71	0.26	0.32
1972	42[3]	1,210	0.26	0.42	0.58	0.94	0.34	0.44
1973	36	862	0.17	0.27	0.48	0.77	0.28	0.36
1974	29	1,299	0.24	0.38	0.39	0.63	0.23	0.30
1975	20	443	0.08	0.12	0.27	0.43	0.16	0.21
1976	20[2]	734	0.12	0.19	0.26	0.41	0.15	0.20
1977	24	516	0.07	0.12	0.30	0.48	0.18	0.24
1978	25	755	0.09	0.15	0.29	0.47	0.18	0.24
1979	31	878	0.10	0.16	0.34	0.54	0.21	0.29
1980	21	812	0.09	0.14	0.22	0.36	0.14	0.20
1981	21	362	0.04	0.06	0.23	0.37	0.14	0.21
1982	26	764	0.08	0.13	0.29	0.46	0.18	0.25
1983	20[4]	809	0.08	0.13	0.21	0.34	0.13	0.19
1984	16[2]	228	0.02	0.03	0.16	0.26	0.10	0.14
1985	22	1,067	0.09	0.15	0.20	0.33	0.13	0.19

1. Owing to incomplete data, the USSR is not included.
2. Includes one mid-air collision shown here as one accident.
3. Includes two mid-air collision shown here as two accidents.
4. Includes one collision on the ground shown here as one accident.

(ICAO Bulletin, June 1986)

(3) Number of fatal accidents, passenger fatalities and survivors by aircraft type in scheduled air services, 1978–1985[1]

(Total, international and domestic; 1985 data are preliminary estimates)

Classification	1978	1979	1980	1981	1982	1983	1984	1985	Total for 8 years
Fatal passenger accidents									
Turbo-jet	11[2]	8	10	6	11	13[3]	2	7	68
Turbo-propeller	9	10	4	9	10	7	10[4]	10	69
Piston-engine	5	13	7	6	5	–	4	5	45
Total	25	31	21	21	26	20	16	22	182
Passengers killed									
Turbo-jet	553	642	698	194	507	762	47	861	4,264
Turbo-propeller	154	174	86	143	192	47	165	179	1,140
Piston-engine	48	62	28	25	65	–	16	27	271
Total	755	878	812	362	764	809	229	1,067	5,675
Passengers surviving									
Turbo-jet	658	153	595	30	1,094	346	109	93	3,078
Turbo-propeller	65	50	11	71	66	44	39	25	371
Piston-engine	8	36	3	13	–	–	–	5	65
Total	731	239	609	114	1,160	390	148	123	3,514

1. Owning to incomplete data, the USSR is not included.
2. Includes one mid-air collision between a turbo-jet aircraft and a small piston-engine aircraft on a training flight (counted as one accident).
3. Includes one collision on the ground between two turbo-jet aircraft
4. Includes one mid-air collision between two turboprop aircraft (counted as one accident).

(ICAO Bulletin, June 1986)