CRANFIELD UNIVERSITY

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THE ECONOMICS OF SAFETY:

A CASE STUDY OF THE UK OFFSHORE HELICOPTER INDUSTRY

SCHOOL OF ENGINEERING

PhD THESIS

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Abstract

The International Civil Aviation Organisation maintains that future viability of air transportation may well be predicated on perception of safety rather than any more tangible measures. In order to keep safety risks at an acceptable level it advocates a change of fundamental approach to the system of safety management, one that is more proactive. This study examines the causes of such a requirement for change, and the scope for improving the efficiency of what Calabresi refers to as the second principal goal of accident law, namely accident cost reduction. First, testing the validity of the traditional approach to safety analysis and management, as stated in regulatory guidelines. Secondly, examining the possibility that the efficiency of safety cost-benefit analysis can be practicably improved.

A subsequent aim is to find an empirically based proxy measure for the acceptability of risk by examining the outcomes to potential safety related risk scenarios. Such a measure, if validated, may convert many existing intangible assessments concerning safety management into more transparent and reliable judgements.

The offshore helicopter industry has many unique characteristics, some of which derive from the fact that the customers, the oil & gas companies, are more powerful than the operators. Others relate to the absence of any intermodal competition, and passengers who are specially trained to be properly aware of their safety. As choice is severely limited, this population is also likely to reflect a much broader range of risk preference. A carefully structured questionnaire was presented to a sample of these passengers, and the responses analysed in depth.

The conclusions of this study are that choice is driven by the perceptions of safety, and that market stability is only maintained with the pre-condition that safety is deemed acceptable. Further, the failure of this pre-condition will follow a predictable pattern, based on a normal distribution for the population. The recommendation of this study is that such reactions to perceptions of safety risk are given due consideration alongside traditional cost-benefit analysis, and in so doing it is likely that more secondary and tertiary accident cost factors will be more fully addressed. This will improve the overall efficiency of accident costs reduction, and make a significant contribution to the aim of proactive safety management.

Foreword

The reasons for taking the slightly unusual step of including a foreword with this thesis document are twofold. The first is to explain how the research question arose, and the second is to explain the motivation for trying to answer it.

Whilst the normal process of research is to establish the need for a research question as a result of conducting the literature review, this literature review merely explores the nature of question that needs to be asked. The justification for this approach is that I can support the need for asking questions about the economics of safety on the basis of twenty years experience operating helicopters on behalf of the military, police, business aviation, and offshore oil support.

Over this time I have endeavoured to understand the industry in which I work better, including earlier research work on why a public service such as the police should spend considerable amounts of its scarce and valuable resources on aviation assets. I have also witnessed times when a new dawn for the helicopter is declared with conviction, only to disappear with as many differing opinions as to why. However, it is rare that the problems of encouraging growth in the helicopter industry are not discussed without the inclusion of some reference to safety.

So, the statistics for helicopter travel must clearly be terrible, because the economics of safety are risk neutral and objective? They are undoubtedly not as good as modern jet airline travel, but in fact UK public transport helicopter operations have a reportable accident rate comparable with that for public transport turboprop aircraft (CAP 763, 2005). Yet, concerns within government and industry about helicopter safety are such that the International Helicopter Safety Team (IHST) was established in 2005 with the objective of reducing helicopter accidents by 80 percent in 10 years. Where is the statistical justification for this initiative, if that is the foundation of the economics of safety? Safety statistics are clearly not as good as jet airline travel, but are they so far short that both government and industry should cite safety as being such a key performance indicator?

Maybe statistics are not enough.

The motivation for this research was borne out of experiences following the fatal accident of a Sikorsky S76A+ helicopter, 16th July 2002, G-BJVX, in the southern North Sea.

I was at the time operating an AS365 helicopter off the North West of Scotland when the terrible news of this accident came through, quickly followed by instructions to move the aircraft and ourselves to Norwich airport. The circumstances were such that although not required by the regulator, manufacturer or operator (a different company to ourselves); Shell had elected to spend considerable amounts of money chartering replacement aircraft of different types to the accident aircraft, as a gesture to their own personnel.

Whilst operating this service for Shell, it became apparent from discussions with passengers that they were forming opinions about safety based on criteria not appreciated by us as professional aircrew. These experiences highlighted that many existing assumptions about safety did not appear to fully explain the situation as it was in the aftermath of that accident.

The question these experiences raised was: 'Is safety the challenge for the helicopter industry, or, is it our understanding of safety that is a challenge for the helicopter industry?'

There is of course the third possibility; that some of the challenges experienced in the helicopter industry are partly due to safety, partly due to our understanding of safety, and partly due to the manner in which safety is communicated.

It is possible that the environment of the helicopter industry highlights shortcomings in our understanding of safety in some way that other sectors of the aviation industry do not. Additionally, a better understanding of the economics of safety under these particular circumstances, of heightened passenger awareness and customer bargaining power, could well improve our knowledge of how safety influences choices under more general circumstances.

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1 Introduction

Dr. Edward P. Warner, the future inaugural president of ICAO, writing as Professor of Aeronautics, Massachusetts Institute of Technology, in 1922, commented that: *"Since it is the fact that the fear of accident is a strong deterrent influence from the use of aircraft, it is very important that the real facts in the matter should not only be determined in such a way as to be available to the technical world, but also that they should be laid before the non-flying public in all possible completeness in order that they may furnish the ground for each individual to make his own decision as to the wisdom of flight for his own purposes."*

In the intervening years there has been a dramatic improvement in the statistical safety of airline travel. As recently as 1972 there were 3.4 fatal accidents per million flight hours for world-wide scheduled services (Taylor, 1988), and from the most recent Aviation Safety Review by the Civil Aviation Authority (CAP 763, 2005) the ten year average for jet aircraft is less than 10% of that, at 0.3 fatal accidents per million flight hours. Today of course air travel is commonplace, to the extent that in International Air Transport Association (IATA) surveys of 'Factors Influencing Airline Choice, Long-Haul', safety scores less than 15% in relative terms to other factors such as schedules, which can be nearly 50% for first-class passengers (Clark, 2001).

However, it is widely suggested that picture may be different for helicopters. In February 2006 Flight International ran a feature on helicopter safety, it was entitled *"Playing Catch Up"*, with the opening line: *"Helicopter Safety is not good enough."* The main source for this statement would appear to be recent US figures, where for 2004 the fatal accident rate for civil helicopters was equivalent to 14.8 per million flight hours. Those US helicopters operating to Part 135 rules during 2004 have a better record, equivalent to 7.8 per million flight hours, as reported in Flight International.

David Lawrence (1991), writing during the time he held the post of Director of Market Planning, United Technologies Sikorsky Aircraft Division, describes the challenges facing the helicopter market thus: *"Often, the helicopter succeeds not because it is a better way, but* *because it is the only way. If it is to escape that embarrassment, it must overcome infrastructural problems, negative attitudes of travellers and the public,.. ..there are three critical technologies that must be addressed, and probably in this order: (1) dispatch reliability and safety, (2) economy and productivity, and (3) amenities : less noise and vibration, and more comfort."*

Safety improvements seem to be so widely cited as the top priority for the helicopter industry that an international initiative to improve safety standards by 80% over 10 years was begun towards the end of 2005, called the IHST. The case for targeting statistical measures of safety as the key performance indicator for sustainable growth in the helicopter industry would appear to be unquestionable. However, safety is possibly the most significant of commercial factors in the UK offshore helicopter industry, a section of the industry that has highly developed safety management systems and has invested considerable resources to making technical improvements. A programme of initiatives that has managed to reduce the fatal accident rate to below 3.4 per million flight hours (CAP 735), or the same as that for world scheduled airline operations in 1972 and less than half that of US Part 135 operators.

It raises the question, are objective measures of statistical safety sufficient to explain the present market conditions, and to achieve the stated objectives for its future growth and viability?

There seems to be an equally strong case to understand what it is about the very nature of safety that eludes the industry. There is an apparent need to determine what it is about helicopters (as a type of technology) that may prove incompatible with current definitions of safety, or to determine what it is about current safety objectives that fails to achieve the overall aim of strengthening demand for helicopter travel.

If it is possible to answer all, or even some of these questions, it is then highly likely that the improvement of knowledge will not only aid the specific problem of strengthening the helicopter industry, but also contribute to wider knowledge about the economics of safety in transportation generally.

Paradoxically, it is the very characteristics of offshore helicopter travel that make it so potentially valuable as a means to explore the nature of safety, and its effect on market conditions. First, there is no choice for passengers but to accept helicopter travel if they wish to work in the offshore oil sector. As pay and conditions are relatively high compared to alternative sources of employment, some people who are more risk averse than the average will still be included in the survey. Whereas, if a similar study into these aspects of safety were to be conducted in any other sector of aviation, these same personality types would likely be excluded, as they may not choose to travel by air. Another factor is that as helicopter travel is effectively part of the terms and conditions of work for this population, so there are many institutions with an interest in air safety, including the employer organisations and the unions. This creates considerable extra pressure on helicopter operators to be transparent. Similarly, there is likely to be far greater awareness of air safety amongst this passenger population.

In all, these conditions and constraints create an environment for study that can justifiably be described as unique within the aviation industry, and, for that matter, amongst most other forms of transport. Such an environment facilitates a comprehensive evaluation of both the behavioural and statistical measures of safety. It also provides good opportunities to assess the validity of any proposed modification of theory and predicted outcomes, against observed organisational behaviour in the face of a safety related crisis. Included amongst these, the accident investigation and aftermath of the accident involving the S-76A+ helicopter G-BJVX.

1.1 Research Goal

Within the system of air transport, explore the relationships between determinants of safety and any consequential economic forces.

2 Literature Review

2.1 Definitions of Safety

"To resolve any complex whole into elements of which it is compounded, is the meaning of analysis; and this we do when we replace one word which connotes a set of attributes collectively, by two or more which connote the same attributes singly, or in smaller groups."
John Stuart Mill, "A System of Logic", 1892.

The very fact that Orville Wright got airborne Thursday 17th December 1903 is testament to the idea that differences of opinion about what constitutes 'safe' have beneficially served the interests of society over history. However, to facilitate meaningful analysis of how these variable definitions of safety influence individual decision-making, and collective decision-making, it is important to try and map the many connotations of the word 'safe', and by extension, 'safety'.

The ICAO states that: *"While the elimination of accidents (and serious incidents) would be desirable, a hundred percent safety is an unachievable goal.. ..Safety is a relative notion, whereby inherent risks are acceptable in a "safe" system"*(ICAO Safety Management Manual, 2006).

The Health & Safety Executive (HSE) in the UK adopts the general principle termed 'Tolerability of Risk' (TOR), but equally concedes that this does not mean the same thing as acceptable risk (HSE, 2001).

'Safety' denotes competing interests between a potential injurer and a potential victim (Calabresi, 1970; Calabresi & Bobbitt, 1978). This translates into several definitions of 'safety', delineated by both variations in viewpoint and context.

Derived from the literature covered here, there would appear to be at least four distinct viewpoints, which are:

- The Technical Viewpoint
- The Legal Viewpoint
- The Political Viewpoint
- The Social Viewpoint

2.1.1 Viewpoints

2.1.1.1 An Engineering or Technical Viewpoint

The engineering approach to safety is centred on the probability of failure, which consequently dominates the creation of airworthiness requirements.

Lloyd & Tye (2002) describe the process of safety assessment as analysing the probability of system failure, which can be divided into six categories (p.7):

a. The effects of single and multiple material failures.
b. The lack of adequate performance with or without material failures.
c. Errors in manufacture or maintenance, some of which can be caused by poor design or inadequate procedures.
d. Pilot mismanagement sometimes made possible by poor arrangement of controls or poor presentation of information, or inadequate procedures.
e. The effects of environmental conditions not adequately catered for in the design (e.g. ice, lightning strikes).
f. The behaviour of passengers, ground handlers and cabin crew.

This approach results in a technical viewpoint, where safety is deemed as the balance between the probability of a harmful occurrence, and the nature and scale of consequences.

Table 1 is a summary of international standards that form the technical definition of aviation safety (Lloyd & Tye,2002, p.36). The purpose is to show the differences in technical definition of safety between Federal Aviation Regulations (FAR) as stipulated in the USA, and the European equivalents (JAR).

This definition is, by extension, used to define many safety goals and objectives, a fact recognised by Reason (1997): *"The most widely used indicator is the number of negative outcomes,.."* (p.108). For example, on the question of a sustainable aviation industry, Upham (2003) makes reference to a report conducted on behalf of the Air Transport Action Group, by INFRAS (2000). In this report, it is maintained that one of the necessary 'social criteria' should be safety, as defined by: “*number of accidents, deaths per year and per unit of transport”* (p.11).

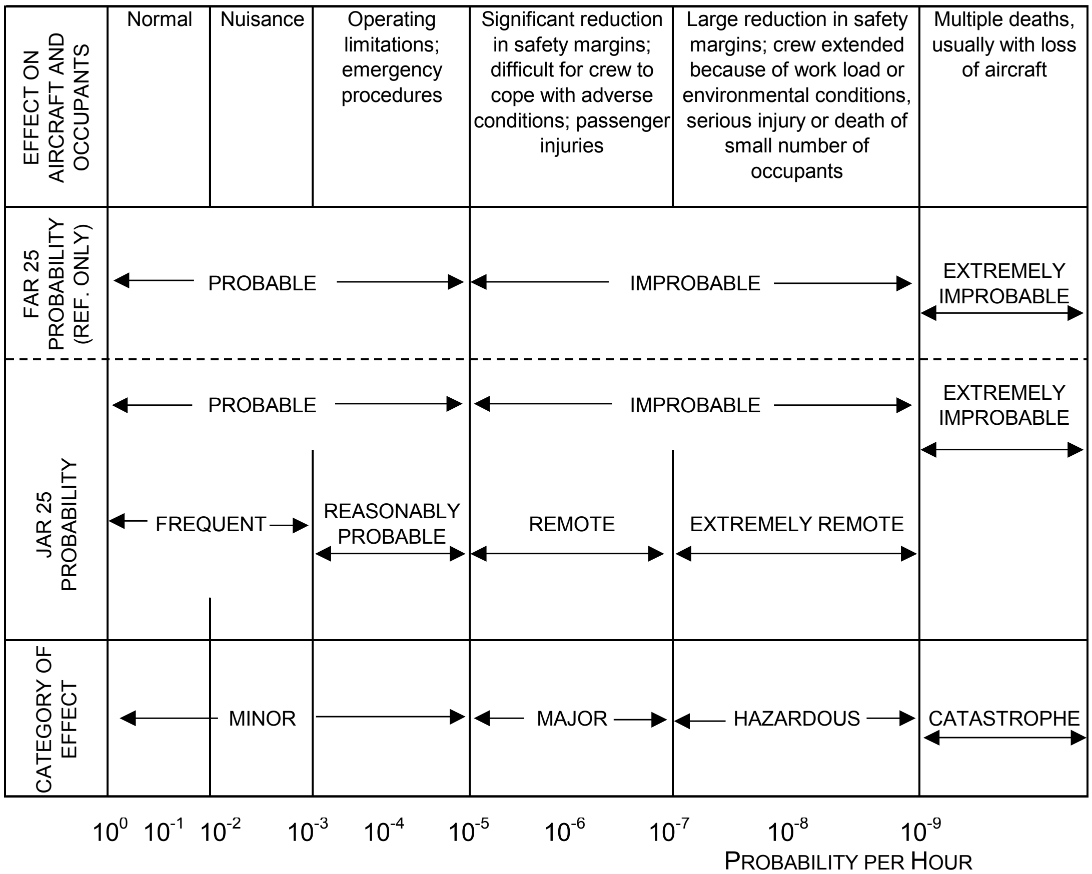


Table 1. Relationship Between Probability and Severity of Effects
(source: Redrawn from Lloyd & Tye)

Some of the use, or misuse, of this definition has attracted criticism. Weir (2000) expresses the opinion that: “*The aviation industry persistently resists new safety measures, but when such attitudes look like attracting widespread criticism it commissions research... ..For misleading uses of statistics, the airline industry is the place to go”* (p.2-3).

2.1.1.2 A Legal Viewpoint

From a legal viewpoint, the definition of safe, and safety centres on assessments of due care (Abeyratne , 1999; Shavell, 1987).

The appropriate level of due care will be influenced by: the likelihood that harm will occur, the nature, scope and scale of harm that can result from an activity, the ability of potential injurers to alleviate risk.

Although similar in some fashion with the technical viewpoint of safety, in that this viewpoint also makes reference to the probability and scale of harm, there are some important distinctions.

As described by Shavell (1987), the consideration of how easy it is for potential injurers to alleviate risk introduces a time frame not evident in the technical definition of safety. For example, if the advancement of knowledge or technology should create an alternative method of reducing risk, then this can influence the assessment of due care, and hence the courts' definition of safety. This notion of obsolescence means that, *"a firm will be held liable for harms resulting from a dangerous characteristic in all units of its product if an alternative, safer design could have been used at reasonable cost"* (p.63).

2.1.1.3 The Political Viewpoint

Expediency plays its part in forming the political viewpoint of safety, in a similar way to any other arena requiring consensus and a degree of international harmony.

Political interest in aviation has been explicit since early days, eloquently characterised by this statement, made by Dr Edward Warner at the Opening Session of the Interim Council of the Provisional International Civil Aviation Organisation, August 1945: *"Our first purpose will be to smooth the paths for civil flying wherever we are able. We shall seek to make it physically easier, safer, more reliable, more pleasant; but I believe it will be agreed also that we should maintain the constant goal that civil aviation should contribute to international harmony. The civil use of aircraft must so develop as to bring the peoples closer together, letting nation speak more understandingly unto nation"* (cited in Abeyratne, 1999, p.10).

However, the problems of achieving international consensus on market related issues, such as routes and capacity, has sometimes resulted in a manipulation of the definition of safety to facilitate other political aims and objectives circuitously.

Golich (1989) has written an authoritative text, "*The Political Economy of International Air Safety*", in which many of the mechanisms for using safety as a political device are described, commenting: "*Industry personnel are concerned that safety regulations and engineering standards may be used to preclude foreign products from markets even though the agreement on technical barriers to trade negotiated under the auspices of the General Agreement on Tariffs and Trade prohibits their use as 'obstacles to international trade'"(p.50); and further, "State elites recognised the potential benefits inherent in dominating the industry and controlling the safety regime" (p.60).*

2.1.1.4 A Social Viewpoint

Any economic system, essentially concerned with the production and exchange of goods, will depend for its efficiency not only on the availability of monetary capital, but also on what has become known as 'social capital' (Putnam, 2000). Sen (1999), discussing social capital, makes reference to the 'complementary values' required for the success of capitalism, *"such as the making and sustaining of trust, avoiding the temptations of pervasive corruption, and making assurance a workable substitute for punitive legal enforcement"* (p.267).

The importance of trust to a system, one characterised by complexity and uncertainty, is that it allows those individuals who may feel disadvantaged by lack of knowledge, information or power, and who subsequently feel vulnerable to harm, to engage in risky activities (Lazaric et al., 1998; Cvetkovich et al.,1999; O'Hara, 2004; Slovic, 2000). Without a general level of trust, many functions or activities of modern society would be unsustainable, or at least be subject to significant volatility and instability. *"Trust is a kind of cement which allows partners to commit resources to collaborative endeavours in contexts where there remains an irreducible element of uncertainty over the outcome"* (Lazaric and Lorenz, 1998, p.209).

Safety remains such an 'irreducible element of uncertainty', and it is for this reason that trust becomes a critical element in the social viewpoint for a definition of safety.

Sjoberg (1999), commenting on the relationship between risk perception and trust, notes that: *"There was some support in the data for the notion that low trust is sufficient to create a high demand for risk mitigation, while high trust is not sufficient to create the opposite, only necessary"* (p.99).

A definition of safety that is predicated on notions of trust is consequently highly dependent on perception: perceptions of risk as a range of probabilities, perceptions of risk as a set of dangers or hazards.

2.1.2 Context

As stated earlier, the second category of variable that emerges from the literature as being critically important to the formation of a given definition of safety is context. Context in this sense is taken as including elements of the cultural framework, such as rationality and perception.

2.1.2.1 Rationality

Earle and Cvetkovich (1999), Adams (1995), Slovic (2000) and Perrow (1999) all describe how people can disagree and argue different viewpoints entirely rationally, founded on cultural premise. As Douglas (1992) elaborates: *"There is no way for protecting the claims for rational foundations of discourse. The ground rules (that is the conditions for knowledge) cannot be tested and proved in the same way as discourse itself is tested. The step-by-step construction of a logical argument, correctly performed, leads to valid conclusions. But though valid, the conclusions may not be accepted as true.. ..The question of foundations is about acceptable categories, not about valid logic."*(p.250-251) The implication being that where the parties to discussion come from ideologically and culturally is as influential on the final outcome as what is being said.

Adams (1995) holds that there are four cultural frameworks on which opinions concerning safety and risk are founded: 1) Individualism, 2) Egalitarianism, 3) Hierarchism, and 4) Fatalism. Slovic (2000) contends that in addition to these four there is another distinct framework, called 'technological enthusiasm'.

Where:

- *Individualism,* is associated with a philosophy promoting market forces, individual responsibility, and which is resistant to State regulation.
- *Egalitarianism*, is generally associated with precautionary approaches to technology and risk, and supporting of State regulation for its protective purposes.
- *Hierarchism,* is generally associated with groups or individuals who look for the answers to risk and uncertainty through institutional structure, and direction from those in authority, both scientific and administrative. State regulation is

supported as much for its corrective purposes as for its protective ones.
- *Fatalism,* unlike the others, is linked with a socio-economic stratum of society (Adams, 1995). The fatalist views risk and danger as a lottery, and any attempt to engage with society to address them as being futile. Adams suggests that this a view prevalent amongst lower socio-economic groups.
- *Technological enthusiasm,* Slovic (2000) proposes this fifth group as distinct from the others, and represented by a view that answers can be found to health and social well-being in technology.

Perrow (1999) iterates the importance of rationality on decision-making, but classifies just three varieties: 1) Absolute rationality, 2) Bounded rationality, 3) Social Rationality.

Where:
- *Absolute rationality*, describes the decision framework where risk and hazard are assessed and balanced purely on objective criteria, probability and expected loss.
- *Bounded rationality*, describes a framework that accepts that decisions are made using mental shortcuts, termed heuristics, which allow people to simplify overly complex problems into more manageable concepts. However, decisions remain essentially concerned with probability and expected loss.
- *Social rationality*, is a term describing a framework of decision making less concerned with the probability and size of any loss, but more concerned with the social consequences of such a loss, in terms of community and social bonding.

2.1.2.2 Hazards, the Perceptions of Safety and Trust

It is the nature of aviation hazards (involving new technology, potential for externalities or consequences, and powerful images) that any perception of safety is necessarily multidimensional, and highly susceptible to context.

Investigation into these aspects of safety has traditionally been the preserve of psychologists, of which there is in fact a wealth of material available. Of particular significance to this study have been the works of Slovic, 2000; Adams, 1995; Perrow, 1999.

Researching the nature of dangers and the perceptions of hazards in general, these authorities on risk all tend to identify similar key dimensions, which ultimately define the acceptability of a given risk. Whilst not all the writers reviewed here consider all eleven behavioural characteristics critically significant, each factor is considered so by at least some.

Summing up the literature reviewed, the eleven behavioural characteristics most relevant to any overall perception of safety are:

- Voluntariness
- Familiarity
- Immediacy & Conspicuousness
- Framing
- Dread
- Control
- Catastrophic Potential
- Equity & Fairness
- Knowledge
- Availability
- Uncertainty & Ambiguity

It is worth noting at this stage that the characteristic of 'peril' is not considered separately, as it tends to be a compound description of others (Slovic, 2000), mainly immediacy and catastrophic potential.

2.1.2.2.1 Voluntariness

Starr (1969) has been able to establish that a significant determinant of the acceptability of risk is the degree of voluntary action involved, suggesting that voluntary risks may be acceptable at as much as 1000 times greater levels than involuntary ones. However, Slovic (2000) also found that the voluntary characteristic of risk tends to be highly correlated with other negatively perceived characteristics, and suggests that voluntariness of risk may just be a circumstance of these.

Adams (1995), whilst accepting that measuring voluntariness is problematic, suggests that there are degrees of volition in taking risk, *"depending on the relative sizes of those imposing the risk and those imposed upon; the greater the relative size of the person or agency imposing the risk, the less voluntary the risk will appear to those imposed upon"*(p.66).

2.1.2.2.2 Familiarity

Starr (1969;1972), as well as proposing a voluntary dimension to risk, found that *"the acceptable level of risk is inversely related to the number of persons participating in an activity"* (cited in Slovic, 2000, p.26)

Douglas (1985) recognises the role of familiarity, and suggests that ignoring everyday dangers is a species survival strategy, and *"allows humans to keep cool in the midst of dangers"* (p.30).

Savage (1998) also considers familiarity a strong influence on risk perception, noting: *"In effect, familiarity breeds contempt for the possibility of risk"* (p.113)

2.1.2.2.3 Immediacy & Conspicuousness

The degree to which victims are identifiable and the degree to which they can be directly associated with an accident, or the consequences of an accident, will greatly affect perceptions of safety. In other words, many events around the world (both natural and technological) can result in far higher numbers of victims than aviation accidents, but will not, somehow, generate the same levels of outrage from the general public. Some of this may be due to the fact many victims (who will in all probability be anonymous) suffer the consequences of the accident many years after the event (e.g., Chernobyl), and are what Perrow (1999) describes as fourth-party victims (future generations). This makes it difficult to create the same awareness amongst the public of the association of losses with the causal event (immediacy vs. delay). Whereas, an aviation accident may create many fewer victims, but they easily become named (with clearly identifiable family connections and human interest stories), and they arise in the moments of the accident itself.

2.1.2.2.4 Framing

Slovic (2000) makes a detailed analysis of how differences in the presentation of information can greatly influence decision-making, without there being any difference in actual informational content. This 'framing' of information is particularly important in risk perception; *"Subtle aspects of how problems are posed, questions* *are phrased and responses elicited can have substantial impact on judgements that supposedly express people's preferences."*(p.166)

A classic example is how the dangers of medical treatment are presented to patients (Tversky & Kahneman, 1986). The same probabilities (invariance) are presented in two frames: 1) a Survival Frame, the numbers living after treatment, and, 2) a Mortality Frame, the numbers dying from treatment. There is generally a greater uptake of treatment when the problem is framed as one of survival rather than mortality.

2.1.2.2.5 Dread

The potential to anticipate death and suffering can weigh heavily on the psyche, and this constitutes a characteristic of certain types of risk termed 'dread'.

Not only does 'dread' affect those in immediate proximity to a given hazard, it is also recognised as a source of 'harm' to relatives and dependents of victims, who can experience suffering, as 'dread', vicariously.

In 2001, US District Judge Charles Legge of San Francisco ruled that relatives of the crash victims in the Alaska Airlines, Flight 261 accident could pursue claims against Boeing for 'the terror suffered by the passengers in the final minutes' (The San Francisco Chronicle, *Judge refuses to delay suit over crash of Alaska Airlines plane*, 23 June 2001)

2.1.2.2.6 Control

Closely associated with the factor of voluntariness (suggested by Starr (1969) as being particularly influential), is the degree of available control over the levels of risk, or risk exposure. Slovic (2000) found that higher thresholds of acceptable risk are generally correlated with activities that can be tightly controlled, or at least give the impression of being under control.

Perrow (1999) classifies risks over which the individual performing the activity has some control as 'active', as opposed to 'passive'. However, Perrow also makes the point that 'active' risks are rarely undertaken for someone else's profit, and so this makes another close connection with the idea of voluntary vs. non-voluntary risks.

If any potential differences in knowledge about risk exposure are ignored or assumed to be balanced, Perrow also makes the point that in any given activity (e.g., transportation); potential first-party victims (operators) will likely accept higher thresholds of risk than second-party victims (passengers), who in-turn would accept higher thresholds than third-party victims (innocent bystanders).

2.1.2.2.7 Catastrophic Potential

Slovic (2000) found another important factor in assessing acceptable risk, closely correlated with voluntariness, that of castrophic potential, stating: *"We conclude that society's apparent aversion to involuntary risks may be mostly an illusion, caused by the fact that involuntary risks are often noxious in more important ways, such as being inequitable or potentially catastrophic"* (p.148).

2.1.2.2.8 Equity & Fairness

Whether or not the benefits derived from a risky activity are considered fairly distributed amongst society, and whether the costs of the same activities result in externalities (costs borne by third- or fourth-party victims), can have a significant bearing on the levels of risk mitigation required, and any general acceptance of the safety hazards concerned (Slovic, 2000; Perrow, 1999).

Douglas (1985) notes that; *"It is often held that perception of risk is directed by issues of fairness.. ..The threshold of risk acceptability in the workplace is lowered when the workers consider themselves exploited"*(p.5).

2.1.2.2.9 Knowledge

The writings of many academics reviewed here, from differing fields of interest, tend toward agreement on the subject of knowledge. That is that knowledge plays a pivotal role in forming perceptions about risk, and particularly any acceptance what is deemed 'safe'.

Awareness of a hazard is the starting point of risk perception (Regester & Larkin, 1997). As writers on risk management, such as

Davidson Frame (2003),point out; before planning a response to a risk it has first to be thought of as possible. In situations that have potential for tragic consequences, the very fact that significant sections of society may either be unaware, or later may become aware of a known hazard, can have a significant impact on the accepted standards of safety. Calbresi & Bobbitt (1978) recognised a phenomenon where 'tragic choices' (e.g., decisions to ration or limit expenditure on safety devices) are accepted by the population at large for as long as the decision is not evidently a choice that challenges fundamental values, termed the 'sufficiency paradox'. So, for example, a decision not to act on many of the Vice President Al Gore led, White House Commission on Aviation Safety's recommendations for improving airport security in 1997 were generally acceptable to the public (Cobb & Primo, 2003), because there was no real awareness of a 'tragic choice' (i.e., convenience to the passenger and cost savings to the airlines winning over possible terrorist threat). However, in a post September 11th 2001 world, many recommendations became a political imperative, almost regardless of cost; because security was clearly no longer 'sufficient', awareness (knowledge) had been triggered, and the tragic implications of the choice were evident to all.

2.1.2.2.10 Availability

Once an awareness of a hazard is alerted, it is widely suggested that perception tends to be heavily influenced by how easily a particular incidence of the hazard is recalled to mind.

As previously reviewed when discussing bounded rationality, psychologists have found that people (either as individuals or as an institution) tend to cope with complexity by simplifying it with rules of thumb, or mental shortcuts, called 'heuristics' (Slovic, 2000; Perrow, 1999; Gowda, 1999; Sunstein, 2002).

According to Slovic (2000); *"..any incident that makes the occurrence of an event easy to imagine or to recall is likely to enhance its perceived frequency"* (p.37).

2.1.2.2.11 Uncertainty & Ambiguity

Adams (1995) describes a state of risk being where the odds of various possible future states are knowable, and uncertainty as one where either the possible future states themselves are unknown (and hence the probabilities are necessarily unknown), or the odds of future states are unknowable. *"It is common in cases of genuine uncertainty for the perceptibility of hazards to be much clearer to non-scientists than to scientists. Most of us, most of the time, navigate our way through life with remarkably simplistic ideas of the threats we face"* (p.199).

A leading theory of choice in the face of uncertainty is called 'prospect theory' (Tversky and Kahneman,1986). The theory describes a set of circumstances where apparently irrational decisions (i.e., decisions that do not maximise expected utility) become rational (or, at least conform to observed rules of behaviour). Of significant interest is the proposed idea that there is a tendency for people to prefer choices that offer either certainty, or the illusion of certainty (pseudocertainty). Slovic (2000) tested this idea via a questionnaire on vaccination, and found that the form of wording that apparently provided complete protection from one strain of disease, and none for another, was received more favourably than an alternative form of wording, presenting the identical scenario as an overall reduction of risk for both strains.

Einhorn and Hogarth (1986) make similar findings, but introduce a concept of 'ambiguity', defined as 'an intermediate state between ignorance and risk', that is a function '*of the number of distributions that are not ruled out by one's knowledge of the situation*' (p.45). It is argued that normal behaviour is to try and avoid ambiguity, and that this tendency could explain why '*new technologies are resisted more than one would expect on the basis of their first-order probabilities of accidents, failures, and so on'* (p.46). The overall effect of decision making under ambiguity is that low probabilities of loss tend to be overestimated (pessimistic view), and comparable win probabilities tend to be underestimated (optimistic view).

2.1.3 Definitions of Safety in Common Usage

"The FAA has no definition of safety – no official definition, that is. Safety is not defined in the Federal Aviation Act of 1958. It is not specified in the FAA regulations. It is not explained in the agency's guidelines. So FAA officials can't say what safety is.." Mary Schiavo, Inspector General, US Department of Transportation, 1990 – 1996 (Cited in: Cobb & Primo, 2003, p.153-154)

However, the ICAO does attempt to provide a working definition of safety in its Safety Management Manual (2006). The ICAO accepts that *"the concept of aviation safety may have different connotations, such as:*

- *a) Zero accidents (or serious incidents), a view widely held by the travelling public;*
- *b) Freedom from dangers or risks; i.e. those factors which cause or are likely to cause harm;*
- *c) Attitude towards unsafe acts and conditions by employees (reflecting a 'safe' corporate culture);*
- *d) Degree to which the inherent risks in aviation are 'acceptable';*
- *e) Process of hazard identification and risk management; and*
- *f) Control of accidental loss (of persons, property or damage to the environment)…*

.. Thus, for the purpose of this Manual safety is considered to be: Safety is the state in which the risk of harm to persons or property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and risk management." (p.1-3)

It should be emphasised that the active part of this definition is "*an acceptable level"*. This is because the Manual goes on by saying that *"The acceptable level of safety shall be established by the State(s) concerned"* (p.1-4). This is an acknowledgment that the definition of safety remains highly political, and that it is a remote possibility that there will not be many variations of 'acceptability' across regions, and even across industry sectors within a State.

Cobb and Primo (2003), rather than trying to resolve the differing concepts of safety into a single definition, argue that disputes arise over the meaning of 'safe' exactly because there are innate differences in definition, rather than just different 'acceptable levels'. It is proposed that there are at least six definitions of safety within the aviation business.

Definition 1: *Safety Defined as the Statistical Probability of Dying in a Plane Crash*
Definition 2: *Safety Defined as No One Being Killed in a Crash*
Definition 3: *Safety Defined as the Absence of Unsolved Crashes*
Definition 4: *Safety Defined as the In-Flight Performance of Planes and Airlines*
Definition 5: *Safety Defined as the Ground Performance of Planes and Airlines*
Definition 6: *Safety Defined as Invulnerability to Terrorism*
(p.154 – 161)
Cobb and Primo point out many of the implications of these definitions, some of which are discussed in more detail below:

Definition 1: *Safety Defined as the Statistical Probability of Dying in a Plane Crash*

This definition tends to emphasise that air travel is statistically safer than any other common mode of transport, and any accident is likely to be both an isolated and rare occurrence. However, it has been pointed out that *'for those who accept this safety criterion, there is no premium on taking immediate corrective action following a crash. Clearly, planes are not unsafe'* (Cobb & Primo, 2003, p.156).

It is also worth noting the comments made by Sunstein (2002) on the significance of risk. Sunstein points out that the significance test of a hazard is a function of not only the probability of loss, but also the size of population affected. By this argument, even the best airworthiness standards of a probability of failure no greater than 10^{-9} (Lloyd & Tye, 2002) becomes 'significant' when a certain level of the world's population become exposed. This concept is also reflected in the opening remarks made by Congressman Norman Mineta to the US National Civil Aviation Review Committee, October 1997: *"It is also clear that the anticipated growth in aviation coupled with the current accident rate [will mean that] the frequency of accidents in the future will become wholly unacceptable"* (cited in: Weir, 1999, p.7).

Definition 2: *Safety Defined as No One Being Killed in a Crash*
Cobb & Primo interpret this as the absolute safety standard, or zero accidents, stated by the ICAO as '*a view widely held by the travelling public*' (Safety Management Manual, 2006, p.1-3).

Definition 3: *Safety Defined as the Absence of Unsolved Crashes*

This definition expresses the concept that accidents can be accepted only provided that the causes can be explained and rationalised. It is a concept closely allied to the findings that people exhibit an aversion to uncertainty and ambiguity, discussed earlier.

One significant implication of this definition is: *"This safety definition is demanding for those involved, allowing no failures and uncertainties on the part of investigators. No matter how long the time period, causes must be found and the public must be given a satisfactory answer"*(Cobb & Primo, 2003, p.158).

Definition 4: *Safety Defined as the In-Flight Performance of Planes and Airlines*

If failures are discovered, then corrective measures need to be taken to ensure no further recurrence. It is implied by this definition that confidence in aviation 'safety' can be sustained provided a system of hazard identification and risk management is incorporated, and effectively maintained.

Definition 5: *Safety Defined as the Ground Performance of Planes and Airlines*

This definition is used by Cobb & Primo to describe a concept that aviation safety can be deemed acceptable on the basis of the perceived quality of regulatory oversight. The implication of this definition is that if the State's regulatory authority appears ineffective, or even incompetent, then overall public perception can be seriously affected.

This concept is supported by other findings on the functioning of institutional trust. *"The result of globalising trust through institutions is to increase both trust and risk simultaneously.. ..It is essential in such circumstances that the institutions are reliable and efficient, and have effective powers of investigation.. ..in the world of institutionalised trust, an institution certifying people as trustworthy had better have proper procedures, because if one of the people it certifies turns out to be untrustworthy, everyone else it certifies falls under a shadow. Uncertainty increases"* (O'Hara, 2004, p.88).

Definition 6: *Safety Defined as Invulnerability to Terrorism*

This definition is included in a text written post September 11th 2001, and it is suggested that: *"Now when a crash occurs, this is the first definition that comes to mind for many"* (Cobb & Primo, 2003, p.161).

Having discovered that safety can, and does, mean differing things to different people, it is important to explore how these distinctions can impact on market conditions.

2.2 The Financial Implications of Safety

"The air transportation industry's future viability may well be predicated on its ability to sustain the public's perceived comfort regarding their safety while travelling. The management of safety is therefore a prerequisite for a sustainable aviation business"(ICAO, Safety Management Manual, 2006, p.1-4).

However, safety is not now, nor has it ever been, the ultimate objective. Safety is a facilitator or enabler of other desired benefits and outputs of air travel. As long as the perceived standard meets the required standard by the customer, then safety is unlikely to feature greatly in the demand function (Savage, 1998).

The aviation industry has been enjoined with many grand objectives, not least those elucidated by Dr Edward Warner (later the first president of the ICAO Council): *"The civil use of aircraft must so develop as to bring the peoples closer together, letting nation speak more understandingly unto nation"* (cited in: Aberatyne, 1999, p.10). Although the outputs of aviation cannot, in all honesty, be said to be entirely beneficial, particularly as awareness of environmental hazards gain in prominence, it undoubtedly has a significant part to play in the global economy (Upham et al., 2003).

The mechanisms by which aviation delivers the various economic and social benefits can be reduced to categories defined by a lowering of transaction costs, enhancing the scale and scope of freedom of movement, and the efficiency of communication. Human capital is thereby enhanced, and the capability of an economy to grow and develop is generally improved.

"We have good reasons to buy and sell, to exchange, and to seek lives that can flourish on the basis of transactions. To deny that freedom in general would be in itself a major failing of a society.. ..The ubiquitous role of transactions in modern living is often overlooked precisely because we take them for granted"(Sen, 1999, p.112).

These attributes are the purpose for which the activity of aviation is undertaken, and will ultimately determine its success. It is therefore against the benefits derived from these attributes that safety will be assessed.

A consideration when assessing the overall utility (or, gain) from undertaking a risky activity is that the benefits (freedom of movement, efficiency of communication, lower transaction costs) are not subject to the same scale factor as the costs (loss of life, damage to property, environmental hazards, etc.). Thus, any overall assessment is subject to not only what is produced (air travel), but also how much is produced, and the nature of consumption (i.e., how many people and how often) (Calabresi, 1970; Calabresi & Bobbitt, 1978; Shavell, 1987).

The judgement translates into whether the presence of extra safety enhances the quantity or distribution of benefits, and whether the absence of safety would similarly detract or add to the costs.

Sunstein (2002) argues that it is only economically efficient to manage 'significant risks', where the degree of significance is determined by the probability of occurrence multiplied by the size of population affected.

If the aviation market were considered 'perfect' (as defined in an economic context), the financial implications of safety could be assessed merely by observance of any shifts in demand and supply. However, the aviation market is considered 'imperfect', and subject to the failings of: 1) producing externalities (including the potential for 'tragic' consequences), 2) asymmetric information, 3) latent conditions, and 4) insufficient resources to fully cover liabilities (Calabresi & Bobbitt, 1978; Needham, 1982; Shavell, 1987).

Savage (1998) suggests that these conditions can lead to two situations of myopic behaviour, both of which rely on imperfect information. In the one case, an unscrupulous company might rely on customers' assumption that safety is being maintained at the required (and previously held) standard to maintain prices, but actually cut costs. This utilises imperfect information to make short run gains by reducing expenditure on safety inputs, in the knowledge that should an accident expose these shortcuts the liabilities will in all likelihood result in bankruptcy. The second case also results from imperfect information, where a company itself does not fully understand the risks and liabilities of conducting operations, and makes insufficient resources available for safety inputs.

For these reasons, the aviation market is a State regulated industry, and, as a consequence, both market and regulatory financial impacts have to be considered.

"The aviation workplace is filled with potentially unsafe conditions which will not all be eliminated; yet, operations must continue" (ICAO, Safety Management Manual, 2006, p.4-22).

2.2.1 The Financial Implications of a Lack of Safety

The ICAO recognises that: *"For most companies, safety can best be measured by the absence of accidental losses. Companies may realize they have a safety problem following a major accident or loss, in part because it will impact on the profit/loss statement. However, a company may operate for years with many potentially unsafe conditions without adverse consequence. Without effective safety management to identify and correct these unsafe conditions, the company may assume that it is meeting its safety objectives, as evidenced by the 'absence of losses'. In reality, it has been lucky"* (ICAO, Safety Management Manual, 2006, p.4-22).

This is a similar expression of factors influencing the finance - safety relationship as those leading to Savage's (1998) theory of 'myopia', discussed earlier, where the present costs of preventative measures are not properly assessed against the potential future liabilities of accidents.

The ICAO considers there to be two types of cost following a lapse of safety (accident or serious incident), including economic losses (such as a loss of business): direct and indirect. Whereas, Calabresi's (1970) seminal work on the costs of accidents describes three categories of cost: 1) primary costs (accident costs), 2) secondary costs (loss spreading & compensation), and 3) tertiary costs (administrative).

Shavell (1987) further argues that as economic losses are intrinsically linked to the particularities of the specific incident (e.g., the economic circumstances of either injurer or victim), they should not necessarily be included as a cost of the accident. Such considerations have the potential to distort and confuse the general conclusions following an accident, and could undermine efforts to find the most efficient accident cost reduction strategy.

Comparisons of the two classification systems are presented in table 2.

Cost Item	ICAO	Calabresi/ Shavell
Hull Damage	Direct	Primary
Medical Treatment	Direct	Primary
Property Damage	Direct	Primary
Loss of Business	Indirect	Economic Loss
Damage to Reputation	Indirect	Economic Loss
Loss of Use of Equipment	Indirect	Primary
Loss of Staff Productivity	Indirect	Primary
Investigation and Clean-up	Indirect	Tertiary
Insurance Deductibles	Indirect	Secondary
Legal Action	Indirect	Tertiary
Compensation & Damage Claims	Indirect	Secondary & Tertiary
Fines & Citations	Indirect	Primary & Tertiary

Table 2. Accident Cost Categorisation

2.2.2 The Potential for Financial Situations to Impact on Safety

Juxtaposing the impact of accidents (and serious incidents) on the financial health of a business is the possibility that the financial health of a business may have an impact on safety.

The ICAO (2006) maintains that there are some business situations that justify extra vigilance from State aviation administrations, and that these include:

- Start-up or rapidly expanding companies,
- Corporate mergers;
- Companies facing bankruptcy or other financial difficulties;
- Companies facing serious labour-management difficulties.

It is not only the ICAO that supposes some interaction between business decisions, financial health and levels of safety.

The Australian House of Representatives (1995) came to the conclusion that: *"..the substantial body of theory taken in conjunction with the available anecdotal evidence and the result of some empirical studies suggest that it is likely that in general, safety deteriorates to some extent under financial pressure"* (p.55).

The U.S. Congress in its investigation *"Safe Skies for Tomorrow"*, expressed concern by stating: *"..new emphasis could be placed on systematic and regular monitoring of financial conditions and management changes at airlines,.."* (p.6).

More recently, the Office of Inspector General, U.S. Department of Transportation (2005) has re-stated similar concerns by stating: *"In response to monetary losses and to compete with low-cost air carriers, network air carriers are making unprecedented changes to restructure their operations.. ..These changes have resulted in a significantly different air carrier industry, which requires a dynamic oversight process to ensure safety is maintained"* (FAA, Report No. AV-2005-062,p.viii).

2.2.3 Existing Evidence for the Financial Implications of Safety

The evidence of major accidents resulting in severe financial crisis for the operator concerned (and, occasionally, by association the other operators sharing the same State of Registration) is strong, but it has been less conclusively established that any reverse relationship is necessarily true.

On the scale of global crisis, Deppa, et al. (1993) report how following the Lockerbie bomb Pan Am's bookings fell sharply, and that in fact 'all American carriers were affected in their international sales'. By December 4, 1991, three years after the crash, the airline ceased to exist.

Mitchell,M. & Maloney (1989) discovered a qualitative nature to market reactions following an aircraft accident. This study revealed a tendency for a loss of brand value, and related loss of demand, for only those crashes whose causes are deemed to be within the immediate control of the airline concerned.

Rose (1992) finds that revenue losses can be great following a significant accident, but as any drop tends to be short term, the declines in equity values are not so considerable.

However, the crash of ValuJet flight 592 in 1996 certainly precipitated the eventual failure of the airline, but the National Transportation Safety Board (NTSB) investigation also notes that ValuJet had been overwhelmed by its rate of growth (Cobb & Primo, 2003). So, this is one case that possibly provides evidence for both types of safety-finance relationship.

Overall, the evidence for financial pressures severely affecting safety is more mixed, and has less general support.

Oster, et al. (1992) comment, *"..most research has found little or no support for the argument that lower profitability is associated with poorer safety performance. This paucity of evidence may be linked, at least partially, with the limited power of statistical tests that is associated with small samples due to infrequent accidents. Safety outputs other than accidents are largely unobservable and difficult to measure, so most studies have tried to examine the relationship between safety inputs and such safety outcomes as accidents and fatalities"* (p.122).

Although there are opposing arguments, in a more recent report Hansen, et al. (2005) suggest that: *"Economic pressures may have also contributed to a series of crashes related to inadequate de-icing that sparked public attention and an agency* [FAA] *response"* (p.39).

In a 1979 study Barnett, et al. found that: *'Generally speaking, airlines that are large have demonstrably better records than those that are small'* (p.1046); but, in a later study, Barnett and Higgins (1989) found little correlation between the size of an individual airline (and therefore its financial resources) and safety performance. This later study did find some further evidence to support the earlier finding that the socio-economic status of the parent State (i.e., State of Registration) has more of a correlation with safety performance.

Rose (1990) did discover some correlation between operator size and safety performance, when it is also associated with profitability. Rose argues where earlier findings are that no such correlation exists, by Golbe (1986) amongst others, it is due to '*infrequency of* *accidents combined with their small sample sizes limits the power of their statistical tests*'p.945. Results of the Rose study suggested that *'lower profitability is correlated with higher accident and incident rates, particularly for smaller carriers*'p.944, where 'small' was defined as less than 75,000 average annual departures and medium as over 75,000 but less than 225,000 departures.

Talley and Bossert (1990), studying profit and operating ratios, determined that worsening financial conditions did prompt a reduction of expenditure on maintenance. However, no evidence was found that this had a significantly detrimental effect on accident rates.

Dionne, et al. (1997) combine many of the above results, and refine the conclusions. On operating margin, it may be a question of whether there are more resources available to spend on maintenance, or whether operating margins have been improved because of a reduction in maintenance expenditure. The more reliable measure, it is suggested, is the level of maintenance expenditure per departure. It is also suggested, contrary to the findings made by Talley and Bossert (1990), that 'carriers do affect their level of accidents by modifying their level of maintenance expenditures'. Dionne, et al. also discovered that levels of debt have a relationship with a company's safety effort, but for small airlines only. "*More debt, for a given level of equity, increases the efficiency of the safety effort by permitting more investments in aircraft, for example.. ..We see that those airlines with large debt and negative equity have more accidents which is consistent with the interpretation that the moral hazard effect dominates the investment effect for airlines that are near-bankruptcy"* (p.394-395).

2.3 Accident Cost Reduction and Market Sustainability

"If passengers ever believe that their lives are endangered by getting on an airliner, the industry itself would be what crashed and burned" (Nader & Smith, 1994, p.xvii-xviii).

As discussed earlier, aviation is an activity that represents risky choices, risky choices that can also have tragic consequences for society, for organisations, and for individuals (Calabresi & Bobbitt, 1978).

A socially optimal solution is found when the value gained from air travel less the cost of taking due care produces market conditions that promote the most efficient balance in demand and supply. Too much demand, resulting from an insufficient allocation of accident costs to the aviation industry, may in turn result in levels of activity (numbers of passenger miles flown) that exceed optimum for public interest. Equally, an overly precautionary approach, produced from excessive levels of care (induced via fear of potential liabilities or from the State electing to pass all the costs of accidents onto industry), may either reduce demand or restrict the supply of air services below the optimum for public interest.

The problem arises as to how to arrive at appropriate measures of 'due care', and appropriate means of apportioning the costs as either incentives for improvements or deterrence against sub-standards, both ex ante and ex post accidents (Shavell, 1987).

Calabresi (1970) commences his seminal work on the analysis of 'The Costs of Accidents' with this statement:

"Some myths will make our analysis difficult if not cleared up. The first is that our society wants to avoid accidents at all costs; the second is that there is an inexorable economic law that dictates the 'right' way to allocate accidents losses; the third is that when critics and courts talk about distributing the risk of accidents they have a specific goal or subgoal in mind; and the fourth is that it is axiomatic that the costs of an accident be borne only by the victim or by the party who may in some sense be said to have injured him" (p.17).

From a public interest point of view, it would be advantageous if cost-benefit analysis could be structured so as to consider the consequences of: ‘trickle-down’ effects of technological development from the manufacture of aircraft (such as an enhanced, highly educated, skills-based workforce); risk substitution (e.g., making air travel so costly, people choose to travel by road, which may in some senses be riskier)(Sunstein, 2002); investment and industry clusters (businesses favour locations which have good airport connections); social benefits arising from tourism and foreign travel (Caves, 2003). Alternatively, an assessment of costs would be more complete if it incorporates factors for: externalities (such as, environmental damage and detrimental social effects from noise pollution); long-term psychological effects of accidents on victims, families of victims, and wider communities; opportunity costs of alternative means of transport (e.g., rail vs. air travel); social costs of encouraging socio-economic clusters around major airport hubs (e.g., North-South geographical divides); other political considerations (such as the interests of minority groups, justice and equity).

In reality, any analysis tends to be bounded: *"Attempts to weigh precisely the social costs and benefits associated with different responses to a tragic choice result more often in the valuation of only what we can measure than in the measurement of all that we value. Costs which are difficult to measure,.. .., will often be left out of the accounting altogether, though the resulting narrowness of the premises will poison the conclusion"* (Calabresi & Bobbitt, 1978, p.204).

In principle, safety measures in transport will be implemented unless the Cost of Preventing a Fatality (CPF) is ‘grossly disproportionate’ (Edwards v National Coal Board, 1949) to the Value of Preventing a Fatality (VPF). An apparently objective criterion that is in fact subject to a high degree of variability based on judgemental factors, supposedly to account for behavioural factors. For instance, the VPF for a main line railway accident is 2.8 times greater than that for a road accident in the UK (Evans, 2005).

This approach is generally explained as a function of variations in the ‘willingness-to-pay’ to avoid risk, depending on the type of hazard envisaged and the available choices to society. There is a view that such variations actually contribute to the efficiency of this type of cost-benefit analysis, as: “*..social decisions should, so far as possible, reflect the interests, preferences and attitudes to risk of those who are likely to be affected by the decisions and (b) that in the case of safety, these interests, preferences and attitudes are* *most effectively summarised in terms of the amounts that individuals would be willing to pay or would require in compensation for (typically small) changes in the probability of death or injury during the forthcoming period."* (Jones-Lee, Hammerton & Philips, 1985, p.49)

An alternative view is that utilising variable VPF amounts (or similarly, Value Of Statistical Life, VOSL (Jones-Lee, et al)) based on a 'willingness-to-pay' approach can result in inconsistencies in policy, and accentuates the difficulties of formulating efficient accident costs reduction policy. A situation highlighted by Evans (2005): *"It is clear from the preceding discussion that society could prevent more fatalities at the same cost by devoting relatively more resources to road safety and less to rail safety. It remains a puzzle that society chooses not to do so, and is apparently content with the present allocation of resources."* (p.8)

2.3.1 Primary, Secondary and Tertiary Costs of Accidents

Calabresi (1970) found that analysis of accident cost reduction strategies is greatly improved if a clear set of goals (justice and cost reduction) and associated subgoals (e.g., reducing administrative costs) are first identified. Calabresi also emphasizes and clarifies differences between the methods (essentially technical) for achieving goals or sub goals (e.g., spreading of costs), and the systems (essentially political) for allocating the costs of accidents (e.g., the fault system, social insurance, or enterprise liability).

Underpinning the whole of this framework of analysis is the concept of classifying costs into three groups: 1) primary, 2) secondary, and 3) tertiary.

2.3.1.1 Primary Costs of Accidents

The most obvious, and directly related group of costs; by definition an accident is an unplanned, unintended event that results in harm, and therefore losses (costs). These costs range from damage to equipment, damage to property and/or infrastructure, and may culminate in injuries to people. Equipment needs to be repaired or replaced; damaged property needs to be secured, repaired or rebuilt; infrastructure needs to be stabilised and reinstated; injuries to victims require medical attention.

2.3.1.2 Secondary Costs of Accidents

Secondary costs are the 'societal costs' (Calabresi, 1970) arising from accidents. These costs include the various compensations to victims, and/or the families of victims.

2.3.1.3 Tertiary Costs of Accidents

Coping with accidents involves organising the resources of multiple parties and organisations, and the arbitration of competing interests. This gives rise to a set of costs concerned with administrating the system, and, in the case of aviation accidents, includes such items as accident investigation, safety regulation, and legal proceedings.

Another aspect of Calabresi's accident cost categorisation system is that it becomes clear that an initiative solely targeted at one category will not necessarily be sympathetic with another, and so the overall effect may be to actually increase overall accident costs.

2.3.2 Directionality

Before reviewing methods of cost reduction, it is important to note that reducing any one group of costs will not always result in an overall reduction in the costs of accidents. In some circumstances targeting the primary costs (for example) will result in an increase in secondary costs. If, for example, excluding all aircraft that weren't multi-jet powered reduced the frequency of accidents, this would result in costs to society (e.g., severely restricting 'feeder' type airlines). Similarly, if all accidents were perfectly compensated (secondary cost reduction), there would be reduced incentives to avoid accidents (primary costs).

"It should be noted in advance that these subgoals [primary/secondary/tertiary cost reduction] *are not fully consistent with each other.. ..We cannot have more than a certain amount of reduction in one category without forgoing some reduction in the other, just as we cannot reduce all accident costs beyond a certain point without incurring costs in achieving the reduction that are greater than the reduction is worth. Our aim must be to find the best combination of primary, secondary, and tertiary cost reduction taking into account what must be given up to achieve that reduction"* (Calabresi, 1970, p.29)

2.3.3 Methods of Accident Cost Reduction

2.3.3.1 Primary Cost Reduction

The methods of reducing the primary costs of accidents are concerned with reducing the frequency and/or severity of accidents, by either discouraging more accident-prone activities or encouraging safer alternatives (substituting one risky activity for a less risky one, or finding safer ways to engage in a risky activity).

Calabresi (1970) considers two mechanisms by which such cost reduction methods can influence primary costs of accidents. The first is termed 'general deterrence', and describes methods that use the market to influence decisions to improve safety standards, or alter supply and demand characteristics (tax systems, subsidies, competition rules, etc.). The second, termed 'specific deterrence', describes those methods that use limits and controls on behaviour and activity (political instruments, regulation and the legal system).

The advantages of market mechanisms (general deterrence) are that they tend to be flexible; any errors introduced can be balanced relatively easily (e.g., shifting costs onto more appropriate parties); the markets react quickly to environmental changes; and general deterrence methods require less sophisticated information gathering to be effective. The main disadvantage is that they tend to be unable to adequately adjust for and/or exclude many non-monetizable items valued by society (quality of life, justice and equity, etc.).

The advantage of specific deterrence methods is that they can allow for non-monetizable values considered fundamental to society. However, the disadvantages are significant. To be effective, specific deterrence requires extensive information gathering (effectiveness of regulation is greatly determined by the accuracy which categories and sub-categories of actions are identified, collated, measured and monitored); specific deterrence methods tend to be slow to react to environmental changes; errors introduced by specific deterrence methodology tends to be less easily balanced or corrected by the rest of the system.

2.3.3.2 Secondary Cost Reduction

"The law cannot avoid placing costs on someone. It can for example decide (1) to leave them on the injured party, (2) to shift them to another party to the accident, (3) to divide them among the parties involved, or (4) to remove them from the involved parties and place them on the taxpayers" (Calabresi, 1970, p.52).

Again, Calabresi (1970) considers two general mechanisms for secondary cost reduction: 1) the 'loss spreading' method, and 2) the 'deep pocket' method.

The argument for loss spreading is founded on the concept that 'accident losses will be least burdensome if they are spread broadly among people and over time' (p.39).

"We need merely recognise that social dislocations, like economic ones, will occur more frequently if one person bears a heavy loss than if many people bear light ones to find adequate support for the spreading of losses" (p.40).

The alternative to loss spreading, the 'deep pocket' method, seeks also to minimise the social dislocations arising from secondary losses. However, this method achieves the aim by placing losses on those categories of people (organisations) less likely to suffer significant detriment as a consequence.

2.3.3.3 Tertiary Cost Reduction

As discussed, tertiary costs are those costs arising from administrating the processes of valuation, analysis, decision-making, consensus building and/or arbitration.

Having effective ways and means to minimise complexity, reduce uncertainty and remove ambiguity can reduce costs of this type.

Many of these functions are similar to those attributed to the building of trust and confidence.

2.3.3.3.1 Trust & Confidence

"Not investigating, not entering into legal relations; these are all signs of trust. The truster clearly benefits from trust. Investigating people and initiating legal procedures are expensive and time-consuming, and indeed can undermine trust; sometimes uncertainty combined with trust is better than certain knowledge" (O'Hara, 2004, p.15).

Bradbury, et al. (1999) describe the social role of trust, and include: a) reducing complexity, b) fostering collaboration, c) enhancing the legitimacy of organisations to act on the behalf of society.

"..trust is more fundamental to conflict resolution than is risk communication" (Slovic, 2000, p. 319)

Confidence is sometimes seen as a distinguishable attribute, in that it describes an expectation that desired aims can be achieved. It is an assessment of technical capability (competence) rather than the integrity of intentions (Metlay, 1999; Bradbury, et al. 1999).

Cobb & Primo (2003) reviewing the crash investigation into USAir Flight 427, make the following observations: *"The crash of flight 427 in September 1994 resulted not only in the death of more than a hundred people but also in a loss of credibility for parties associated with the investigation. Once the plane went down, many assumed that the cause would be determined quickly.. ..First, the status of the NTSB, as the agency whose mission is to investigate air disasters and inform the public about them, was challenged and weakened. After exhaustive, expensive testing and the passage of five years, all that was produced were conclusions based on circumstantial evidence"*(p.77).

2.3.3.3.2 The Fault System

Another major contributor to tertiary costs of accidents is the arbitration of competing interests (injurers, victims and the public), and administering the system of accident law.

Calabresi (1970) is critical of the fault system as a method of achieving efficiency, and the maximum accident cost reductions. These inefficiencies arise because the 'fault system' can only consider the role and interests of the parties involved in the legal proceeding, and the costs can only be attributed accordingly. It cannot, for example, adjudge that some costs would be best borne by society as a whole.
Additionally, a legal proceeding is concerned with the peculiarities of an accident or case, whereas the public interest is more served by considering the recurring events or characteristics. Last, but not least: *"..fault leaves some victims destitute, overcompensates others, and does both with such enormous delays that it creates yet another source of secondary costs based on the delay itself"* (p.278).

The crash of Alaska Airlines flight 261 in January 2000 resulted in 88 cases, and some four years of legal proceedings. In addition, the final settlements were very variable, 'anywhere from a couple of million dollars up to $20 million' (Associated Press).

Shavell (1987) in making an economic analysis of accident law, seeks less to examine the relative merits of the 'fault system' as a means of achieving the goal of maximising a reduction in the costs of accidents, and more on how different liability rules can influence behaviour. The characteristics that influence the choice of liability rule include:

i) Whether the likelihood of an accident occurring is influenced by the behaviour of both the potential injurer and the potential victim (bilateral accidents), or solely by the injurer (unilateral accidents).
ii) Whether or not the appropriate levels of due care be easily defined, and whether, once defined, key actions are evidently present or lacking (e.g., any evidence of keeping 'a good lookout' is generally restricted to the credibility of a particular witness).
iii) The level of likely harm, and the probability of harm.

iv) Market power, and the level of knowledge a potential victim (customer) is able to reasonably gain about a potential injurer's behaviour and levels of care.

The key liability rules to be chosen from are:

A) Strict Liability, where the injurer pays costs regardless of the levels of care exercised.
B) Negligence Rule, where liabilities are only incurred when the injurer has been shown to demonstrate less than 'due care'.

Shavell (1987) examines in detail the likely consequences on total accident costs, and the levels of care promoted by these rules (along with associated variations, such as; strict liability with the defence of contributory negligence, comparative negligence, and negligence rule with the defence of contributory negligence).

It is the unilateral nature of aviation accidents, and the likely scale of harm, that favours applying strict liability rules. *"The more important it is for injurers to take care, the greater the relative appeal of strict liability.."*(p.16).

On the effects of administration costs, Shavell notes: *"Not only does the presence of administrative costs mean that the socially appropriate versus the privately motivated use of the liability system becomes an issue, it also introduces a new consideration into the determination of optimal levels of care: accidents are socially more expensive if they involve administrative costs in addition to victims' direct losses, so optimal levels of care should be higher on account of administrative costs.."*(p.269).

2.3.3.3.3 Safety Investigations

Another major source of tertiary accident costs are the conducting of investigations, either as a means of supporting the fault system or other regulatory alternatives, as utilised within air transport.

"A process conducted for the purpose of accident prevention which includes the gathering and analysis of information, the drawing of conclusions, including the determination of causes and, when appropriate, the making of safety recommendations." Annex 13 to the Convention on International Civil Aviation.

2.4 The Role of Accident Investigation

"Establishing a cause after a loss-of-life incident reassures the public that order exists in the world. Absent a definite cause, an individual's sense of order is weakened. Randomness is feared because it does not allow a problem to be 'solved'"(Cobb & Primo, 2003, p.60).

The role of accident investigation agencies has evolved from before dawn of aviation, to ensure that lessons are properly learned and the public interest safeguarded in the aftermath of accidents. It was quickly learnt that in the absence of reliable information, a frightened public would assume accidents are uncontrollable and mysterious, and that travel was therefore something to be dreaded.

Mass transportation represents a vital part of any State's economic infrastructure, and any weakness in the system necessarily attracts political attention.

In the face of a rising number of railroad collisions in the latter part of the 19th century, and to counter a trend that carriers investigating their own accidents only resulted in 'hushing up the results', some US states started establishing bodies such as a 'Board of Railroad Commissioners' to solve the problem (Aldrich, 2006). Many of these bodies were modelled on the British Board of Trade, already charged with investigating accidents and making recommendations. Even at a time in the US when Federal involvement and regulations in general were little favoured, it was considered by many that 'publicity was the best remedy for railroad dangers' (Aldrich, 2006, p.72).

In a similar fashion, from commercial aviation's earliest days it was realised that: *"They* {those actively involved in civil aviation} *realize that the incompetent pilot and the un-airworthy plane are a menace to the competent pilot in an airworthy craft. Not only are they desirous of avoiding this menace to their personal safety but they also realize that every accident in aviation tends to retard its popularity, alienates public support for municipal airport projects and increases the cost of insurance to the legitimate operator."* (Woolley, 1929, p.323)

James G. Woolley, was writing in 1929 about the future commercial success of air transport, and at the time was Vice-President, Western Air Express. He also noted that: *"Through the* *establishment of these air navigation facilities and the use of safe aircraft, piloted by skilled personnel under proper regulation, public confidence in air travel will finally be won, and the airplane will be accepted as a dependable carrier, just as the railroad, the steamship and the automobile are accepted today."* (p.342)

It is interesting to note that the first federal US legislation concerned with aviation, the Air Commerce Act of 1926, was framed in two parts. One part was concerned with duties charged to the Secretary of Commerce dealing with the promotion of commercial aviation, and the other concerned regulatory powers. Registration of aircraft, licensing of pilots and inspections of facilities were all covered in the second part, but 'investigation and publication of causes of accidents in civil air navigation' (Woolley, 1929, p.330) was in the first. This suggests that from the first, providing re-assurance to the flying public, and creating a foundation of trust and confidence was recognised as an economic imperative for the government (or, its agents).

Although the situation in Europe was not quite the same, the purpose of investigation was essentially the same. Whereas in the US Federal Government preferred policies aimed at encouraging commercial development of aviation, here it was almost immediately considered a strategic, national asset and, furthermore, something appropriate for government control. In Britain, the Air Navigation Act 1920 incorporated powers for the Secretary of State for Air Power to make regulations for the investigation of civil air accidents, which resulted in the Air Navigation (Investigation of Accidents) Regulations 1922.

Establishing a working framework of institutions that can in the one instance encourage growth and economic prosperity for the aviation industry, and in the other maintain the public's confidence that the public interest is being safeguarded, has been a process of trial and error. At the beginning of commercial aviation in the US, these duties of encouraging its commercial development and for ensuring safety standards resided in the one agency. This may have contributed to some of the factors that resulted in the airmail scandals of 1933 and 1934. A federal Aviation Commission was quickly established to investigate the circumstances of these situations, and make 'recommendations of a broad policy covering all phases of aviation and the relation of the United States thereto' (Airmail Act of 1934. Cited in; Burkhardt, 1967, p. 12). One of its findings was that many commercial operations, in order to win contracts, were being operated at a loss, and that this contributed to aviation's poor safety record at the time (Burkhardt, 1967).

Although there have been various changes to the framework over the intervening years, the role of investigation as distinct from regulation remained evident. This is in part due to the need to investigate the role of the regulator, and regulations as contributing factors to accidents. In fact, even when the US created the FAA in its present form in 1958, accident investigation remained within the remit of the Civil Aeronautics Board (which also had responsibility for economic regulations of air carriers) (Burkhardt, 1967). The NTSB itself was not formed until 1967, and it did not gain full independence from the Department of Transportation until 1975.

The economic importance of an effective accident investigation system remains of great significance: *"The TWA flight 800 investigation cost Boeing, the FBI, and the NTSB at least $87 million.. ..The impetus for greater airline safety was quashed by the inability of the NTSB to determine the precise cause. This allowed the FAA to enact weak standards with reference to cost-benefit analysis.. ..Causal uncertainty allows those who wish to contain an issue to keep regulations from being implemented."* (Cobb & Primo, 2003, p.118 – 119)

The economic impact of accident investigation can also have international consequences. Golich (1989) notes: *"..changes in Europe's approach to safety regulation were triggered by dissatisfaction with the US handling of the 1974 and 1979 DC10 disasters."* (p.68)

It remains the case that it is solely the role of accident investigation to recommend changes that will enhance future safety. It is for the regulatory authority to assess the need for any proposed changes and to determine the most appropriate methods of implementation. An inevitable part of any such assessment process will be the costs.

2.5 Cost-Benefit Analysis

"As for those who assess everything by financial benefits and advantages, refusing to allow these to be outweighed by the honourable, often in their thinking they compare the honourable with what they conceive as useful." Cicero

Cost-benefit analysis (CBA) in itself does not justify the decisions of industry and government, but it is generally accepted as being a necessary part of the decision making process for all. *"Exploratory calculations, of course, do not prove anything. A proof about the future is in any case impossible, and it has been sagely remarked that all predictions are unreliable, particularly those about the future. What is required is judgement, and exploratory calculations can at least help to inform our judgement."* (Schumacher, E.F. ,1973, p.15)

Thus, when bad decisions are made, it is not often a problem with the analysis tool in itself, but more often the use of the results. There have been some infamous cost driven decisions made by the aviation industry. Most notably as outlined in a memo from F.D. Applegate (Director of Product Engineering, Convair), concerning problems identified in the DC-10, 27th June 1972: *"My only criticism of Douglas in this regard is that once this inherent weakness was demonstrated* (failure of the cargo door) *by the July 1970 test failure, they did not take immediate steps to correct it. It seems to me inevitable that, in the twenty years ahead of us, DC10 cargo doors will come open and I would expect this to usually result in the loss of the airplane. This fundamental failure mode has been discussed in the past and is being discussed again in the bowels of both the Douglas and Convair organizations. It appears however that Douglas is waiting and hoping for government direction or regulations in the hope of passing costs on to us or their customers.*

If you can judge from Douglas's position during ongoing contract change negotiations they may feel that any liability incurred in the meantime for loss of life, property and equipment may be legally passed on to us.

It is recommended that overtures be made at the highest management level to persuade Douglas to immediately make a decision to incorporate changes in the DC10 which will correct the fundamental cabin floor catastrophic failure mode. Correction will take a good bit of time, hopefully there is time before the National Transportation Safety Board (NTSB) or the FAA ground the airplane which would have disastrous effects upon sales and production both near and long term. This corrective action becomes more expensive *than the cost of damages resulting from the loss of one planeload of people."* (Golich, 1989, p. 117-118)

Before two years were out, on the 3rd March 1974, a Turkish Airline DC10 crashed with the loss of all onboard over the French countryside, due to the catastrophic failure mode identified in this memo.

2.5.1 The Requirements for Cost-Benefit Analysis

The issue about whether or not government regulatory agencies should conduct a cost-benefit analysis of their actions is no longer about principle. That argument was largely resolved by the end of the 1980's in favour of its proponents. However, there is still some debate to be had about how cost-benefit should be done (Sunstein, 2002; Needham, 1983).

The ICAO recognises that analysis of some safety recommendations will depend on credible cost-benefit analysis, and further states: *"Sometimes, cost-benefit analysis may suggest that accepting risk is preferable to the time, effort and cost necessary to implement corrective action."* (ICAO, *Safety Management Manual*, Ch.9 p.3)

Along with other UK government agencies, the UK CAA is required to make decisions that conform to government policy, one of which is to conduct a Regulatory Impact Assessment before mandating any changes to safety requirements. *"New regulations should only be introduced when other alternatives have first been considered and rejected, and where the benefits justify the costs."* (Tony Blair, British Prime Minister, *Better Policy Making: A Guide to Regulatory Impact Assessment,* p.1)

In the U.S., there is Executive Order 12866 (September 30, 1993), which requires that: *"Federal agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating,.."* (Hoffer, et al., 1998, Appendix A)

2.5.2 Guidelines for Cost-Benefit Analysis

Whilst both U.S. and U.K. regulatory guidelines consider the broader issue of economic analysis, incorporating both Cost-Effectiveness and Cost-Benefit analysis, only the latter is considered here. That is because in the case of the Cost-Effectiveness technique, the objectives have already been established as worth achieving, and the only issue remaining is how best to do it. In the case of Cost-Benefit, the objectives need also to be justified. This is more often the situation when evaluating safety recommendations.
Hoffer, et al. (1998) outlines the framework of analysis as:

1. Define the Objective
2. Specify Assumptions
3. Identify Alternatives
4. Estimate Benefits and Costs
5. Describe Intangibles
6. Compare Benefits and Costs and Rank Alternatives
7. Evaluate Variability of Benefit-Cost Estimates
8. Evaluate Distributional Impacts
9. Make Recommendations

(p.2-3)

Where the safety objective is listed as a single category, and assumptions are limited to items such as the cost of fatalities and injuries (rather than any underlying issues of value, or philosophical approach).

A section of this FAA guideline dealing with estimating the benefits of safety is given below:

"Safety may be defined in terms of the risk of death, personal injury, and property damage which results from air transportation accidents. A major responsibility of FAA is to reduce the incidence of such outcomes. FAA carries out this function through its capital investment, operations, and regulatory functions. The evaluation of the benefits of such activities requires determination of the extent to which deaths, injuries, and property damage resulting from preventable accidents will be reduced, and that these reductions be valued in dollars. This subsection presents methodology for determining deaths, injuries, and damages prevented by risk reduction. Once known, these can be valued in dollars by applying standardized DOT and FAA economic values." (Hoffer, et al., 1998, p.3-5)

'Economic Values for FAA Investment and Regulatory Decisions, A Guide', states that valuations for preventing injuries and death are done on the basis of a Willingness to Pay (WTP) approach. The 2001 valuation of avoiding a fatality is $3 million, and for avoiding a serious injury $580,700.

The guide also gives a value for the cost of a major accident investigation, at $8.5 million. However, a 'major accident' in this sense is one involving a heavy airliner, and an offshore helicopter accident would more probably be classed as 'Air Carrier', which is costed at $449,000.

In the U.K., guidance is contained within *'Better Policy Making: A Guide to Regulatory Impact Assessment'*, published by the Cabinet Office, and *'The Green Book'*, published by HM Treasury. However, these books are much more general policy guidelines, that cover every aspect of government business.

It is worth noting that there are a number of value statements in these guidelines, including:

- *"The cost-benefit analysis should reflect the values and needs of society".* (Cabinet Office, p.71)
- *"Do not forget any indirect benefits – changes in behaviour that can have additional effects."* (Cabinet Office, p.71)
- *"the sooner the benefits and the further into the future the costs, the better."* (Cabinet Office, p.73)
- *"The UK, along with other developed countries, is committed to using the precautionary principle."* (Cabinet Office, p.79)

On the subject of intangible values, *The Green Book* recommendation is:

"5.76 Costs and benefits that have not been valued should also be appraised; they should not be ignored simply because they cannot easily be valued. All costs and benefits must therefore be clearly described in an appraisal, and should be quantified where this is possible and meaningful." (p.34)

In common with the U.S., the UK uses a WTP principle to 'value a prevented fatality', at round £1.145 million (in 2000 prices), and £128,650 for serious injury. These figures are considerably less than the ones used in the U.S.

In a recent CAA paper, *'A Benefit Analysis for Cabin Water Spray Systems and Enhanced Fuselage Burnthrough Protection'*, it is stated that: *"All benefits derived are based on the number of lives saved for the world fleet of western-built aircraft type certified for more than 30 seats and are relative to the period 1967 to 1996."*(p.1)

2.5.3 Challenges for Cost-Benefit Analysis

"The "second generation" debates raise difficult questions about how (not whether) to engage in CBA – how to value life and health, how to deal with the interests of future generations, how to generate rules of thumb to simplify complex inquiries, how to ensure that agencies do what they are supposed to, how and when to diverge from the conclusion recommended by CBA, how to determine the roles of agencies and courts in contested cases." (Sunstein, 2002, p.xi).

Sunstein (2002) identifies three key potential problems with CBA: *"poor priority setting, excessively costly tools, and inattention to the unfortunate side effects of regulation"* (p.6).

Comparing this point with the process of analysis defined by Hoffer, et al. (1998) in the FAA guide, the considerations that will most affect these issues are:

- Defining Objectives
- Making Assumptions
- Describing Intangibles

2.5.3.1 Objectives

Calebresi (1970) argues that the goal of safety, as defined by organisations such as ICAO (2006), is too broad an objective on which to perform any meaningful analysis.

To achieve meaningful analysis, Calabresi argues that the accident costs should be categorised according to three sets of objectives, objectives that are not wholly compatible.

As discussed in earlier sections of this chapter, to eliminate totally the primary costs of accidents in aviation will not necessarily improve the overall goal of reducing total accident costs, as higher secondary costs (social costs) may be incurred as a result. For example, to achieve this reduction in the primary cost of accidents, one mode of transport becomes relatively expensive, and activity shifts to an alternate mode that has higher risks (say, road transport).

Similarly, a system of compensation that eliminates all secondary costs may create its own hazards, by reducing incentives to avoid accidents in the first place (primary costs).

So, Calabresi argues that to pursue any one objective to the exclusion of others will eventually produce a negative total impact. It is therefore important to sub-categorise objectives as far as reasonably possible, as it is the overall balance of measures that achieves efficiency in cost reduction, not any particular one.

2.5.3.2 Conditions Affecting the Efficiency of Cost-Benefit Analysis

"The advantage of studying models is that they allow predictive and normative questions to be answered in an unambiguous way. Practicality, however, requires that models be kept simple; although there is no conceptual bar to introducing in them all manner of complications, admitting even a few tends to make models difficult to solve or interpret. Thus, the understanding of reality gained from models must be inexact, and rough judgements about the fit of models must be made." (Shavell, 1987, p.3)

Taking into consideration all the issues discussed, there would appear to be four critical factors which will most affect the overall efficiency of safety cost-benefit analysis, and any resulting accident costs reduction:

- The nature of choice and risk preference.
- The appropriateness of any value placed on preventing injury or death via the 'Willingness-to-Pay' (to avoid risk) (WTP) method.
- The assessments of significant risk.
- The influence of intangible factors.

2.5.3.2.1 The Nature of Choice and Risk Preference

Economic theory largely supposes that the aggregate description of any market situation is equivalent to individual decision makers making choices solely on the basis of expected outcomes, and that these cannot be significantly influenced by the process of making the choices (Hogarth & Reder, 1986).

Psychologists argue that the way in which an argument is framed can have a significant impact on the eventual choices made by both individuals and, in an aggregate effect, the market (Slovic, 2000; Tversky, A. & Kahneman, D., 1986).

2.5.3.2.1.1 The Rational Choice Paradigm

Hogarth & Reder (1986) describe an economist's view of rationality as when decision makers behave in a manner that conforms to what is termed the 'rational choice' paradigm. *"This paradigm, expounded in many textbooks and treatises, supposes that the individual decision maker has a utility function whose arguments are defined as alternative uses of the resources with which he or she is endowed. The quantities of these resources are interpreted as constraints on the possible choices available to the decision maker, so that rational behaviour consists of determining the set of resource quantities to be devoted to each of the possible uses as the solution to a constrained maximization problem.. ..recent applications of the paradigm have included descriptions of phenomena such as variations in the numbers of crimes committed, births, marriages, law suits and so on as outcomes of changes in the costs (i.e., in the resource constraints) of such actions to the decision makers."* (pp.2-3)

In a generalised case this desired outcome, termed 'utility' (U) can be defined as a function of differing amounts of goods (x).

$$U=f(x) \qquad \text{(i)}$$

The shape of the resulting utility curve will help determine many issues, including the point at which maximum total utility is achieved. A point where and any further increases in good (x) fails to increase overall utility (or, well-being) and may in fact reduce it, as alternative uses of resources would result in larger gains. This point is taken as where Marginal Utility (MU) is zero.

$$MU = dU/dx = 0 \qquad (ii)$$

Of equal relevance to this study is the concept that given the same constraints and choices, different people may have different forms of the equation (i). The shape of this curve will be largely determined by the risk preference exhibited by a given individual.

It is important to note that the terms 'risk neutral' and 'risk averse' have a very specific set of meanings in economic terms. *"A fair gamble is one which on average will make exactly zero monetary profit… ..Economists classify individuals as risk-averse, risk-neutral, or risk-loving. The crucial question is whether or not the individual would accept a fair gamble. A risk-neutral person pays no attention to the degree of dispersion of possible outcomes, betting if and only if the odds on a monetary profit are favourable.. ..A risk-averse person will refuse a fair gamble. This does not mean he or she will never bet. If the odds are sufficiently favourable the probable profit will overcome the inherent dislike of risk."* (Begg, et al, 1994, pp. 237-238). However, for the purposes of the study, it is suffice to note the description given by Shavell (1987):

"8.1.1 Assumption of risk aversion. In contrast to risk-neutral parties, risk-averse parties care not only about the expected value of losses, but also about the possible magnitude of losses. Thus, for instance, risk-averse parties will find a situation involving a 5 percent chance of losing 20,000 worse than a situation involving a 10 percent chance of losing 10,000.. ..even though each of the situations involves the same expected loss of 1,000. (Risk-neutral parties would not find any one of the situations worse than any other.) Risk-averse parties, in other words, dislike uncertainty about the size of losses per se." (p.186)

This means that when dealing with an issue such as safety, it is not only important to consider actual utility, but also expected utility.

Expected Utility (EU)

=

Utility of Possible Consequence x Probability of Possible Consequence

If an individual exhibits risk-averse behaviour, then the shape of the resulting utility function will be concave in relation to wealth (or resources, health, etc.), chart 1.

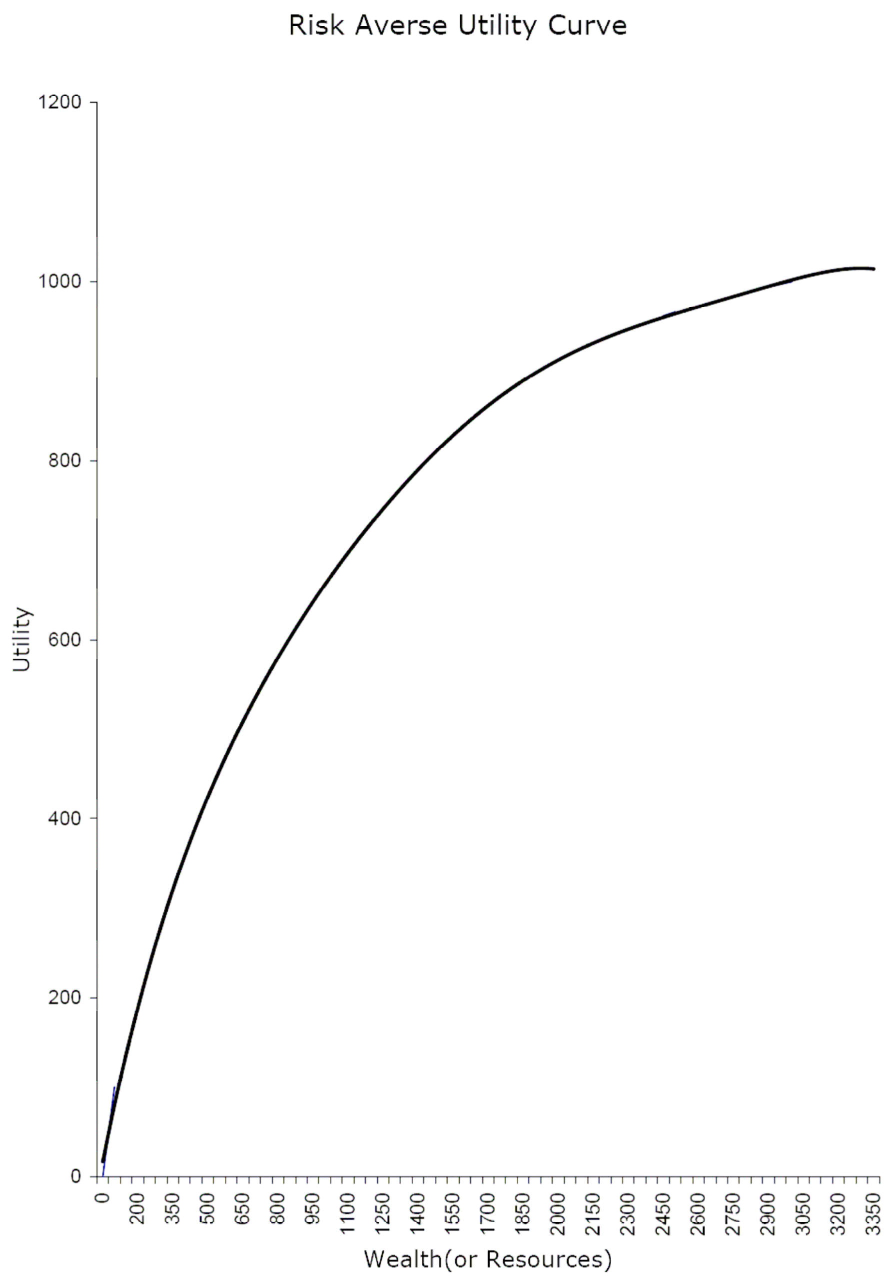


Chart 1 (re-drawn from Shavell, 1987)

As can be seen from chart 1 (re-drawn from Shavell, 1987, p.188), some consequences of this type of utility function are:

- An individual is likely to view the expected disutility of loss involving the same reduction in wealth as more important than an equivalently risk averse organisation with greater resources.
- The cumulative outcome of a group of individuals faced with an expected loss may not be equivalent to that of an organisation acting as agent facing a similar loss.

In the case of providing safety, chart 1 is clearly a simplification and is just used to illustrate the shape of a typical risk-averse utility curve. However, it is natural to assume that an individual with only one life available to lose is likely to be more risk-averse than any government acting on their behalf, even if members of that government are also risk-averse.

One method used to compensate for such limitations is to set a value of statistical life, or value of preventing a fatality, by empirical means (Jones-Lee, et al, 1985).

2.5.3.2.2 The Appropriateness of Any Value Placed on Preventing Injury or Death Via the 'Willingness-to-Pay' (to avoid risk) (WTP) Method

"It is morally indefensible to work out the money value of life – especially when it is different according to where you come from. Doing so makes an international agreement impossible. Yet without trying to count the real cost, it will be very hard to reach a real bargain." (Boyle, 2001, p. 211)

With reference to the section on 'rational choice', it is worth recalling that economists view rationality as finding a '*solution to a constrained maximization problem'.* However, the anthropologist Mary Douglas (1985) points out that: "*The question of acceptability of risk involves freedom as well as justice"* (p.10). In essence, any value placed on life is going to reflect social and economic opportunities of the group or community being studied.

This means that whether a cost-benefit analysis is performed utilising 'willingness-to-pay' (WTP) or 'willingness-to-accept' (WTA) values for risk can have a very significant influence on any subsequent recommendations (Slovic, 2000; Adams, 1995). This is because WTP values will generally be significantly less than the equivalent WTA values. One consequence of using WTP values (as recommended in both U.S. and UK guidelines) is that there is a cost difference, borne by the potential victim of any accident, which will be left uncompensated (Calabresi, 1970; Shavell, 1987). This may constitute a social cost, or secondary accident cost (Calabresi, 1970), which potentially undermines the overall efficiency of the recommendation.

Another difficulty of utilising such values is that they are generally based on empirical studies (Jones-Lee, et al, 1985) that summarise the results of questionnaires comparing opinions about differing risks of injuries and death, at a given time. As indicated by the work of psychologists (Slovic, 2000; Starr, 1969) these views are likely to change with improving technology and increasing familiarity, and so it is difficult to imagine that even inflation adjusted values of such figures remain fully valid for long.

However, the main consequence of WTP values remains that it introduces cultural and geopolitical aspects to the analysis; demonstrated by the difference between the FAA value of a prevented fatality and the UK value. *"Cost-benefit analysis also relies heavily upon current market prices for evaluating costs and benefits. Yet these reflect current economic arrangements that many might question and wish to change. For example, people with low earning power can receive lower prices on their lives."* (Perrow,1999, p.310)

2.5.3.2.3 Assessments of Significant Risk

Current international airworthiness standards set specific probabilities for acceptable risk, according to the severity of expected outcome following a failure of the component or system concerned (Lloyd & Tye, 1982).

However, Sunstein (2002) makes the point that a significant risk is defined by two terms. Whilst one is the probability of occurrence, the other is the exposure of risk. In other words, even an extremely low probability of risk can still become unacceptable if enough people are exposed to it in such a way as to make the total number of injuries, or deaths, alarming. A point iterated by a senior

Boeing official in 1993: *"We have to halve the accident rate by the year 2000 just to stay where we are. Otherwise, we could face a major commercial jetliner accident somewhere in the world every couple of weeks".* Paul. D. Russell, chief of product safety, Boeing Commercial Airplane Group, April 26, 1993 (Nader & Smith, 1994, p.xiii).

It is also worth noting that low probabilities of loss tend to be overestimated (Einhorn & Hogarth, 1986). A consequence of this is that individuals may form a view that their expected disutility of injury or loss bears little resemblance to the disutility expected by a regulatory authority, who is in possession of more accurate data; even if perceptions about the consequences to any loss are the same.

The other difficulty alluded to in this Boeing official's comment is that improving safety has greatly increased the marginal costs of safety inputs. A point re-iterated in the ICAO Safety Management Manual, 2006:

"1.6.3 Historically, aviation safety focused on compliance with increasingly complex regulatory requirements. This approach worked well up until the late 1970s when the accident rate levelled off. Accidents continued to occur in spite of all the rules and regulations.

1.6.4 This approach to safety reacted to undesirable events by prescribing measures to prevent recurrence. Rather than defining best practices or desired standards, such an approach aimed at ensuring minimum standards were met.

1.6.5 With an overall fatal accident rate in the vicinity of 10^{-6} (i.e. one fatal accident per one million flights), further safety improvements were becoming increasingly difficult to achieve using this approach."

2.5.3.2.4 Intangibles

All three groups of organisations (ICAO, FAA, & UK Government) make clear in their respective guidelines to conducting cost-benefit studies, some qualitative considerations are problematic when trying to create any meaningful monetary valuation, or other proxy measure.

"10. In the absence of an existing reliable and accurate monetary valuation of an impact, a decision must be made whether to commission a study, and if so, how much resource to devote to the exercise. Key considerations that may govern a decision to commission research are:

- *Tractability of the valuation problem: whether research is likely to yield a robust valuation;*
- *Range of application of the results of a study to future appraisals;*
- *How material the accuracy of the valuation is to the decision at hand. This may be gauged through sensitivity analysis around a range of plausible estimates; and,*
- *Scale of impact of the decision at hand. If the decision relates to a multi-billion pound programme or to regulation that will impose costs of similar scale upon industry, it is clearly worth devoting much more resource to ensuring that the valuations of the non-market benefits (and costs) are accurate than would be appropriate for a smaller scheme."* (Green Book, Annex 2, p.58)

This decision, therefore, relates to two earlier stages of the cost-benefit analysis. First, whether the underlying objectives recognise the potential importance of some intangibles; for example, should the objective of the analysis be to assess the number of prevented fatalities and injuries, a study where some difference in quality of life is researched is unlikely to be justifiable, by these guidelines. Secondly, the nature of the assumptions will greatly determine whether the 'scale of impact' criteria for commissioning any study are met.

Summarising the literature reviewed for this study, how intangibles make an impact fall into two broad categories:

- Social Values
- Unintended Consequences

"Tragic choices come about in this way. Though scarcity can often be avoided for some goods by making them available without cost to everyone, it cannot be evaded for all goods. In the distribution of scarce goods society has to decide which methods of allotment to use, and of course each of these methods – market, political allocations, lotteries, and so forth – may be modified, or combined with another. The distribution of some goods entails great suffering and death. When attention is riveted on such distributions they arouse emotions of compassion, outrage, and terror. It is then that conflicts are laid bare between on the one hand, those values by which society determined the beneficiaries of the distributions, and (with nature) the perimeters of scarcity, and on the other hand, those humanistic moral values which prize life and well-being.. In such conflicts, at such junctures, societies confront the tragic choice. They must attempt to make allocations in ways that preserve the moral foundations of social collaboration." (Calabresi & Bobbitt, 1978, p.18)

Calabresi and Bobbitt developed a theory that describes the process of making tragic choices as an evaluation in two stages. The first, called a 'first-order determination', is a decision about how much of a scarce resource should be provided. The second, termed a 'second-order determination', is concerned with how that resource is distributed to society. *"Many tragic, second-order choices are, of course, violently unstable. To be stable, at a minimum, somehow second-order decisions themselves must be able to be perceived as not-life-negating."* (p.142)

The other major group of intangibles are those that result from unintended consequences. *"The importance of unintended consequences has been emphasized in different ways by Adam Smith, Carl Menger and Frederich Hayek, among others. If most of the important things that happen are not intended (and not brought about through purposive action), then reasoned attempts at pursuing what we want might appear to be rather pointless"*. (Sen, 1999, p.250)

The aviation industry certainly exhibits the effects of this phenomenon. The inefficiency and poor customer service levels of state regulated airlines were two of the key drivers for market deregulation from the late 1970's onwards (Upham, 2003). However, it is extremely unlikely that the growth of low-cost airlines, and many of the industry changes, let alone the social changes, brought about as a consequence were anticipated at the time.

2.5.4 Reactions to Cost-Benefit Analysis

One theory proposed by Cohen, March and Olsen (1972) is that institutions have a tendency to attach ready-made solutions to problems, and that any analysis by way of justification is made to fit the chosen answer to the issue. This theory they called: 'A garbage can model of organizational choice.'

Possibly the most cautious assessment of cost-benefit analysis was expounded by Needham (1983): *"Two elements of any "problem of regulation" – a model of regulation and a value system used to evaluate regulation – automatically determine the conclusions reached regarding regulation's effects, benefits, and costs. Not surprisingly, there is considerable competition between individuals and interest groups for the right to define these two elements and the nature of specific problems of regulation. This right conveys the ability to formulate a problem of regulation in such a manner that the conclusions correspond to those desired by the problem formulator: the right to define a problem automatically conveys the ability to influence the prescribed solution to the problem".* (p.7).

Mary Douglas (1985) also similarly noted that: *"Cost-benefit analysis would give very different results if applied within different ethical systems. An ingenius attempt to work out ethical foundations of cost-benefit analysis defines four ethical systems.. ..utilitarian .. ..egalitarian. ..elitist.. ..libertarian."* (p.15)

However, Boyle (2001) states : *"There is nothing wrong with cost-benefit analysis, as long as you remember what a benefit and a cost means."* (p.203). Although, he also noted that: *"It's strange how the figure of $1 million comes up when people don't actually know what something is worth.."* (p.212).

Some more specific criticisms of cost-benefit analysis, as used within the environment of air transport, have been made:

"The manner in which cost/benefit analysis has been used to stifle safety is a travesty. It is wrong to deny the flying public safer transport because of some arbitrary equation, especially one that is so imprecise. The bean counters in the FAA aren't psychics. They

cannot know how many lives actually will be saved by a proposed rule." (Nader & Smith, 1994, p.37)

A point reflected by these comments regarding the still ongoing discussions concerning safety recommendations for fuel tanks: *"In August 2001 a report provided to the FAA noted that all methods to render fuel non-flammable were too costly and did not satisfy cost-benefit analysis.. ..In response to the FAA report, Jim Hurd, one of the task force members who had lost a son on the TWA flight, said, "The report basically says it's acceptable to have a fuel tank explosion every four years.. ..It was my duty to be the conscience for the group. When they say it's acceptable to have another fuel tank explosion, I say, 'Is it really acceptable?'""* (Cobb & Primo, 2003, p.117)

One highly experienced air accident investigator even suggests that cost-benefit analysis has sometimes been used as a political tool to excuse inaction: "*We do research to say we are doing research. The idea is not to do anything, say you are doing research and wait until the fuss has died down.. ..they then apply cost-benefit analysis and say it is too expensive."* (Eddie Trimble. Cited in: Weir, 2000, p.234 – 235)

The author of many seminal works on accident prevention, Professor Reason notes any cost-benefit analysis of safety recommendations is faced with a very particular problem: *"Decision-makers must decide how to allocate their resources. If they give money to production, they can look to their productivity figures for immediate feedback. But the pursuit of safety gives negative feedback: you are winning when you hear nothing. It is not a compelling reason for investing in safety."* (James Reason. Cited in: Prince, 1990, p. 120)

2.5.5 An Alternative Technique

Despite some negative reactions to cost-benefit analysis, it remains the case that competing schemes and alternative uses of resources have to be assessed in some way. When it comes to improving safety, as part of these assessments it is argued that some value has to be placed on preventing a fatality. *"To put into place procedures and equipment that will save lives, a value must be placed on these lives in order to know how to allocate funds amongst contesting improvements."* (Cobb & Primo, p.35)

There are however some alternatives, or at least variations, on this type of analysis. One is discussed briefly here.

Most regulations are enacted because of some customary approach to solving a market failure, of one type or another. In the case of safety, it has often been pointed out that passengers do not have enough specialist knowledge to enable the market to operate efficiently. However, Savage (1998) proposes that some advantages of the market mechanism could be utilised by disseminating information on safety inputs. If, rather than making assessments of how effective a safety input is likely to be, a statement of the levels of safety inputs provided by each operator were made available to the general public, then demand for safety would be better reflected in the price mechanism. *"Examples might be the average experience of the staff, the age and condition of equipment, and the level of safety-related expenditures. Information of this type will be especially useful in ameliorating the market failure due to myopia."*(p.134)

"Socially-optimal behavior will only occur if fully-informed customers make rational choices consistent with their desires and economic incentives." (p.202)

2.6 Inferences From the Literature

It is a matter of record that many effective safety measures have been enabled in the past as a result of what the ICAO (2006) terms the 'traditional' method of safety management, with its associated cost-benefit analysis on the basis of the WTP principle. However, a logical inference from the weight of evidence presented in the literature is that there now exist reasonable grounds for exploring alternative measures of acceptable risk to augment the existing guidelines.

The key issues are:

a) Safety has improved to the level whereby there are diminishing marginal returns on new inputs and increasing marginal costs.

b) The traditional basis of analysis is essentially reactive, and therefore more suited to accidents where primary costs are of dominant concern.

c) WTP values are based on empirical studies, and these may not be frequent enough to remain appropriate in light of rapidly changing technology and social conditions.

d) It is possible that as the nature of safety management changes to a more proactive approach (ICAO, 2006), it is secondary and tertiary accident prevention measures that will dominate. Such safety inputs (e.g. enhancing certainty through improved accident investigative aids and technology) are not well suited to justification on the grounds of WTP principles alone, and decision making becomes reliant on regulatory authorities exercising judgement.

e) The nature of risk preference can have a significant bearing on the acceptability of risk, and that the sum of individuals' disutility is not the same as the disutility for society faced with equivalent risk.

f) It may be possible to describe and validate an individual utility function, incorporating variables for risk perception and preference (Savage, 1998), but such a description for a group or society would likely be too complex to be reliable.

g) The range of choices available to an individual faced with an issue of safety is limited, and so even though the utility function itself may be complex the outcome is relatively simple. By making an empirical study of these outcomes, or likely outcomes, it may be possible to generate a practicable proxy measure for the acceptability of risk.

Given these inferences, the logical next step is to consider the following possible descriptions of the world:

1. There is no marked aggregate risk aversion evident amongst individuals, and all individuals are in possession of near perfect information. Choice in the aviation market is conventionally rational, and all decisions relating to safety issues will continue to prove efficient if made on a traditional basis.

2. Choice in the aviation market is affected by behavioural characteristics, and therefore perceptions of safety. However, these perceptions are intangible, and any improvement in the

overall efficiency of safety policy is only possible through judgemental decisions.

3. Choice in the aviation market is affected by behavioural characteristics, and therefore perceptions of safety. It is possible to measure these perceptions and use the information to form a behavioural economic model of choice, associated with a quantifiable system of analysis that can improve the overall efficiency of safety policy.

3 Methodology

3.1 Hypotheses

3.1.1 Traditional View of Accident Costs Reduction

The present regulatory guidelines for safety analysis are most efficient when the main concern is preventing primary accident costs. For this policy to result in an efficient overall accident costs reduction the aggregate response from individuals should not exhibit any marked risk aversion, and they should be essentially well informed about the probabilities of an accident. The first test is therefore to discover whether or not this is in actuality a valid premiss.

3.1.2 Behavioural View of Accident Costs Reduction

If individuals exhibit a consistent tendency toward risk averse responses to safety risk and are not well informed, then a logical inference is that safety analysis augmented by behavioural principles are more likely to reflect the real aggregate responses to safety risks. The second test is to explore the validity of this alternate economic view.

3.2 Research Objectives

1. In order that the present statistical method of safety analysis proves most efficient, it is a necessary assumption that aggregate responses to safety issues average out as being similar to that of a risk neutral and objective observer. The first objective is to test the likely range of validity of this assumption.

2. The ICAO has proposed that market stability 'may well be predicated' on the perceptions of safety. The second objective is to explore the range and relevance of perception attributes in determining attitudes amongst passengers towards air transport.

3. If the assumption stated at Objective 1.) fails, cost-benefit analysis may prove more useful if conducted on a different basis. The third objective is to investigate the possibility of measuring the cost-benefit of safety inputs and recommendations against shifts in demand.

4. Should strong evidence emerge that the attributes of perception are instrumental in forming attitudes and subsequent decision-making, maintaining trust and confidence in the system is by implication a necessary competence. The fourth objective is to investigate the nature and role of paternalism in achieving effective governance of aviation and air transport.

5. The evidence may suggest that a behavioural economic model for the economics of safety more accurately reflects the observed behaviour of the system. If this should prove the case, the fifth objective is to induce the logical consequences of such a description, and seek evidence that supports these expected outcomes from observed experience.

6. The final objective is to propose methods by which any new information discovered can enhance the decision-making process and efficiency of safety management, as exercised by legislative and executive bodies.

3.3 Methodology

When selecting the most appropriate methodology, that both achieves all the research objectives and also answers the underlying questions posed by the two hypotheses, it is necessary to consider the study as being in parts. Some parts lend themselves to a positivistic methodology and others to a phenomenological approach. Each part will answer different research questions, but the meaning of the whole would be incomplete without them all.

Consequently, a case study methodology appeared applicable (Yin, 1994): i) the research aims were both to explore and understand the phenomena of safety, ii) the research questions were not pre-fixed, neither were the limits of study fully defined, iii) and, there were opportunities to use multiple methods of data collection and research during the study. The UK offshore helicopter industry had already been selected for study, because not only levels of statistical safety but also perceived safety had been observed (anecdotally from years of experience in the operation) to be of accentuated importance to the commercial viability of the industry sector. This 'unit of analysis' (Hussey & Hussey, 1997) is thus one where all the potential definitions of safety would most likely be evident

It was the intention to develop the case study methodology along the lines of grounded theory (Glaser & Strauss, 1967). As a result, it was decided to design the case study as a four stage process. First, to confirm the findings of earlier studies that suggest there is little or no correlation between safety performance and financial performance. Secondly, to collect data about behavioural aspects of perceptions, induce which of the possible factors of safety actually influence decision-making, and how important they are. Thirdly, deduce the likely consequences of the resulting 'definitions of safety'. Finally, examine recorded circumstances (accidents and their aftermath) for evidence of these theoretical consequences.

3.3.1 Replicating Earlier Research Findings

The first stage was to try and replicate the results of earlier studies that had attempted to establish links between safety standards and financial performance for operating companies. Although there is no question about the validity of these earlier studies, it was deemed important to reproduce it. The reasons for doing this are twofold. It is possible that the particular circumstances of the offshore helicopter market, notably the power of oil companies being so relatively strong, could produce a situation where a conventional economic model of rational choice genuinely operates. This would indicate that the answer to any failing in the present use of cost-benefit analysis lay more in the asymmetry of information, rather than any significant flaw in underlying assumptions about the market behaving in a risk neutral and objective manner. The second reason was that many researchers (ref. 2.2) held that the lack of accident data contributed to the lack of conclusive results. These same researchers believed that the wider data available from general occurrence data could not be used because of the variability in reporting standards amongst operators. This is another factor that could be greatly reduced in the case of offshore helicopter operations, because of the standardised nature of operations and the greater pressure on transparency, produced by the power of the customers.

The aim of this part of the study would be to take the basic approach adopted by earlier researchers (ref. 2.2), and just change the details of the method. It is possible that using all occurrence data (dismissed by earlier researchers as being unreliable, Barnett et al., 1979) and sub-categorised to finer detail, it could result in data with improved validity. Conceivably, such a procedure would produce evidence that is more conclusive, against which these earlier hypotheses could be tested. This approach was considered sufficiently viable to warrant testing. A comprehensive study of all UK helicopter Mandatory Occurrence Reports between Jan 1995 and Feb 2004 was conducted, amounting to over 3400 individual reports, and then compared with corresponding financial records submitted by the operating companies. However, the results were still largely inconclusive on the matter of a link between safety performance and financial performance.

The meaningful result is that the conclusions are similar to earlier research, and the study serves merely to confirm that the market conditions of offshore helicopter operations are consistent with other modes of air transport in this aspect. For this reason, a full description of this part of the study is attached at Appendix A, rather than the main document.

Having confirmed that findings from earlier research could be replicated, it was a strong indication that an alternative approach was needed if the two hypotheses proposed were to be tested.

3.3.2 Interviews, Focus Groups and Surveys

It was established during the literature review that any definition of safety is subjective, heavily influenced by interests and perception. The only methodology available for investigating the power of perceptions of safety is a phenomenological one. There does remain a decision about whether to use focus groups, some form of behavioural experimentation or surveys. In reality, this decision was less about the best quality of data available and more about the best quality available given the resources.

Collecting data about the perceptions of safety was divided into four phases, with an end objective to establish which of the factors discussed in the literature review were evident, and how important they each are (or, are likely to be).

It was realised that a survey method was going to be most cost-effective as the main part of study, but that some extra resource devoted to a small-scale focus group type study at a preliminary stage would deliver dividends. This first phase was a preliminary investigation, consisting of interviews and group discussions with a small cross-section of stakeholders in the offshore oil industry (low skilled workers, high skilled workers, an oil installation manager, aircraft engineers and pilots). The purpose of this stage would be to:

- Remove or reduce any bias imposed on the structure of the survey resulting from the background of the researcher.
- Establish how the theoretical characteristics of perception, identified in the literature, become manifest in the context of offshore helicopter travel.
- Investigate the possibility that some extra factors might become evident that had not been revealed during the literature review.

- Establish the factors of safety most likely to reveal any groupings and differences between stakeholders.
- Establish the most effective way to conduct any subsequent survey.

Taking the time and effort to conduct this phase of the research made a significant contribution to the overall study. The discussions and interviews did indeed reveal many instances where opinions were not as expected, and revealed new information that was worth investigating. This process also made it possible to determine the levels of enthusiasm for the different types of survey technique. For example, it was made clear by participants that any internet based survey would likely fail, as access to the internet is limited on offshore platforms, and respondents almost certainly wouldn't complete a survey from home. Each discussion and interview is presented in tabulated form at Appendix B, and against each topic there is an entry in the final column to indicate the nature of underlying issue(s). This information was then used as the principal guide in the design of a questionnaire.

Although there were many interesting issues raised by the preliminary investigation work, much of it justifying further research, this survey would be concentrating on how perceptions of safety are built, and possibly more important, eroded – and to what effect. The task was to come up with a questionnaire design that would be both comprehensive and yet still manageable.

It had to be borne in mind that the potential respondents in this survey get continual demands for survey material, for a wide range of reasons (though, anecdotally, rarely if ever about helicopter operations). The other major concern about a questionnaire-based survey is that the commercial environment of offshore oil production is extremely complex, with multiple interests ranging from transnational oil companies, through to union and government organisations. Therefore, at every stage it was extremely important to gather a broad consensus of approval, which tended to be time consuming. However, discussions with Shell Aircraft Ltd resulted in gaining the support of this very key stakeholder. It was realised that any of the many differing interest groups had the capability to bring the whole research to a halt, but the endorsement of such a key organisation made that less likely.

The second phase was questionnaire design. Having made the decision to endeavour for broad participation in a limited survey, rather than small-scale participation in an exhaustively detailed survey, question selection was critical. As previously discussed, the group discussion phase was highly valuable, and facilitated the questionnaire design as follows:

- It helped to express the theoretical material covered in the literature in terms familiar to potential respondents.
- It helped identify which factors of perception could be investigated with reasonably simple approaches, and which might require more complex, multiple questions with slight variations.
- It helped reduce ambiguity.
- It helped maximise the available value from the limited number of questions.

A tabulated analysis of the output from the questionnaire is included at Appendix C, indicating which questions covered which areas of material from the literature review.

The first draft for the questionnaire was formulated in September 2004, and given to a small sample of potential respondents as a trial run in November 2004. Some of the results of these trials were merely technical, in that they highlighted some need for amendment (generally a need to reword questions so as to avoid potential ambiguity, or to remove 'jargon'), but others were of a more fundamental significance. The early indications were that the results of the full survey would demonstrate some ways in which the viewpoints or 'mental model' adopted by various categories of stakeholder differ in critical ways. These were likely to be very important if supported by the main survey. This raised a further problem. To remain on schedule, a relatively small survey would be necessary (given the available resources, technical difficulties of accessing a large range of stakeholders from an equally diverse range of organisations, and locations). However, it was evident that in order to fully test the findings of this trial phase of study, it would be critical that the sample should be as representative as possible. As the results of the trial study were potentially so significant for the ultimate validity of the research, the questionnaire had to be distributed as widely as practicable. This meant that the survey had to go to every base of operations, so that all the possible variables were covered, these included:

- The Northern North Sea is generally infrequent, long sector travel in large cabin helicopters.

- The Southern North Sea is characterised by generally more frequent travel, but in smaller aircraft and for short sectors.
- The Northern North Sea is deeper water and generally oil fields, the Southern North Sea is much shallower and generally gas fields, and so the size and structure of platforms is different.

As part of the continuing process of maintaining broad industry support, the amended questionnaire was then distributed amongst some of the key stakeholders with this power to effectively thwart any practical research. After many weeks of communication, some degree of consensus was achieved around January 2005, and the questionnaire, attached at Appendix C, was the final version given to passengers and helicopter personnel operating in all the major helicopter terminals.

The technical difficulties of managing this ambitious survey with the limited resources available to the study did make it the most time consuming phase of study. However, it remained absolutely vital that the sample was representative of the population. Eventually, this approved survey ran in the terminals serving the southern North Sea over the summer and autumn of 2005 (Norwich, Great Yarmouth, Humberside, Blackpool), and in the major northern North Sea hub of Aberdeen over the winter of 2005/6.

The many negotiations required during the whole survey process was a significant source of delay in this study, and, as a result, the final data collection from the questionnaire was only completed in March 2006.

The questionnaire survey resulted in 309 completed returns, which equates to approximately 0.6% of the total offshore population, and represents over 20,000 points of data.

3.3.3 Data Analysis and Validation

The next stage of research was to analyse this data returned as part of the survey, and arrive at some conclusions about the relative importance of the various factors that go to form perception. A full report on this part of conducting the survey is given in Chapter 4.

There is some novelty in arriving at knowledge that places a relative scale of importance on attributes of perception, but it is insufficient to meet all the objectives. A further objective is to make an alternative set of economic assumptions to those of a 'risk neutral and objective' rational choice. To achieve this, the data needs to be combined in some manner so as to arrive at a measure that represents the overall perception of safety. Such a measure is needed to provide a meaningful mechanism for any behavioural economic model of safety.

Finally, it is important that any expected outcomes to changes in the perceived safety risk are tested and validated against recorded events.

For many offshore helicopter accidents this is really only possible by examining archived press coverage, for reports of organisational behaviour in the aftermath. However, with the extensive co-operation of Shell Aircraft Ltd and AAIB, it was possible to make a detailed analysis of the S76 G-BJVX accident aftermath.

This deeper analysis of the results presented in Chapter 4 is given in Chapter 5.

4 The Perceptions of Safety Survey: Results & Analysis

4.1 Perceptions of Safety

4.1.1 Data Analysis

The questionnaire (Appendix C) had been designed to take no more than 15 minutes to complete. Wherever possible, the questions were designed with a 'tick-box' format and an ordinal scale to aid analysis.

The questionnaire delivered 6 variables about the demographic of a particular respondent (1 of which is induced by which helicopter base the return came from). On a fully completed questionnaire, the 32 further questions (including part questions) would result another 61 variables. There were also 3 separate opportunities for respondents to give additional comments (to add to the validity of the data, and to provide further opportunities to gather unexpected data).

Some questions ask for similar data, but only in areas where it was evident (from the preliminary survey) that there could be a tendency to give a subjective response, and asking subtly different forms of question might balance out. That is, 'subjective' in the sense of being different to what might be the revealed preference in a different methodology of study.

The plan was that the questionnaire would test all the factors identified during the literature review, and some additional ones discovered during the preliminary survey process. Tables attached at Appendix C, along with the questionnaire itself, give a scheme for the survey, where question numbers are associated with the corresponding factors that could be induced (dependant not only on the question, but also on the answer).

4.1.1.1 Software

Data from the questionnaire survey was input to SPSS 12.0.1 for windows (available at Cranfield University under an academic licence), and was also used for the majority of subsequent analysis.

Some additional analysis was performed with the help of two programs 'resample.xls' and 'resamplenrh.xls' (Wood, 2003), downloaded from the Palgrave Macmillan website (www.palgrave.com).

4.1.1.2 Demographics

The demographics of the survey sample are presented below, along with associated statistics for the population of offshore oil workforce (provided by Shell U.K. Exploration and Production).

As previously stated, the sample totalled 309 completed returns, of which 247 were other than helicopter operator employees. The total workforce equates to about 43,000, and so the sample is approximately 0.6% of the population.

The percentage of female respondents in the survey was 4%, which compares with the 3.5% in the workforce as a whole.

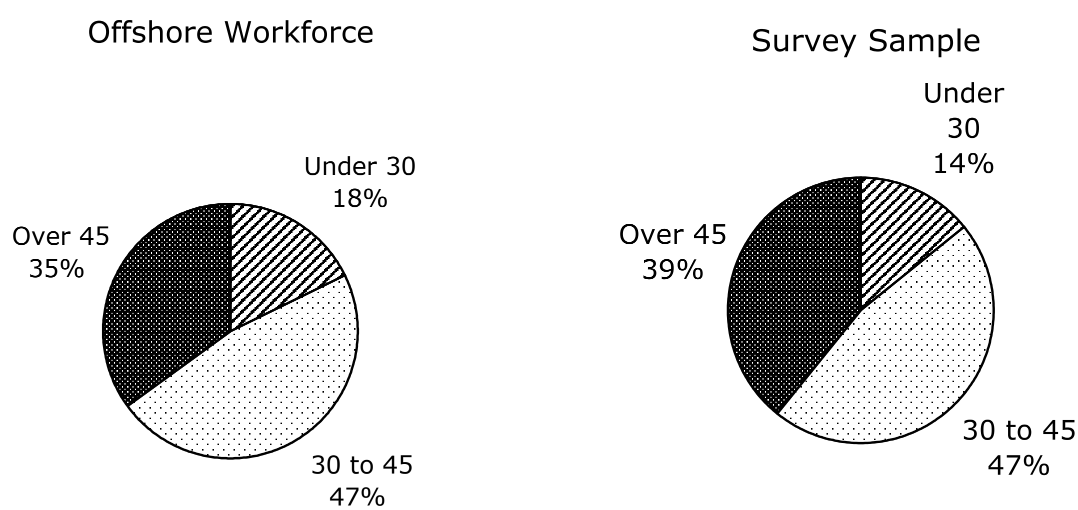
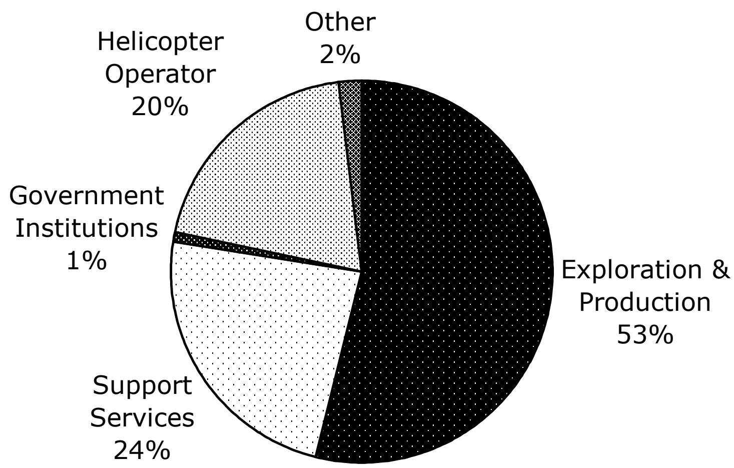


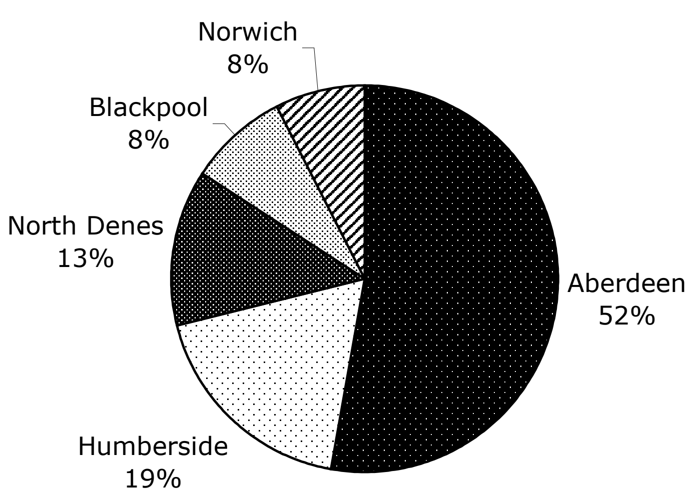
Figure 1. Age Groups

Figure 2: Employer Organisation



n=308

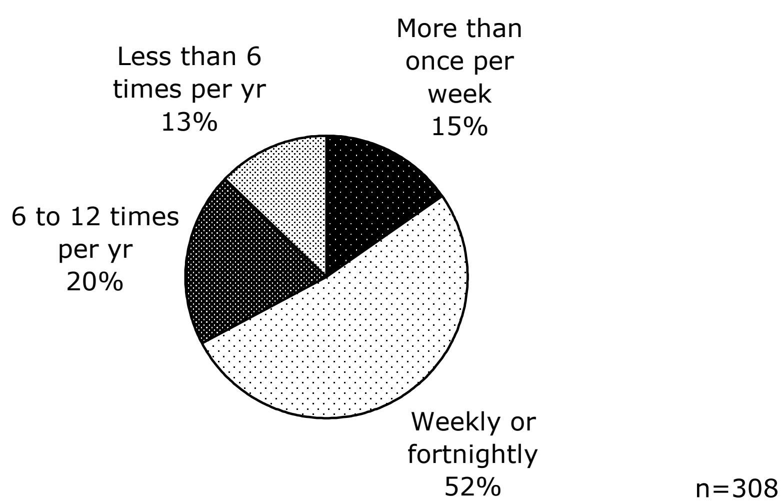
Figure 3: Helicopter Terminal



n=302

The CAA collects data on flying hours and the sectors flown by offshore helicopter operators, some of which was provided for use with this study. The aggregate data for 2002 indicates that the heavy classes of helicopter (AS332 & S61) (concentrated in Aberdeen) did around 74,000 sectors, and the medium fleet (AS365 & S76) (concentrated in the southern sector of the North Sea) approximately 86,000. However (anecdotally) the typical sectors flown in the southern sector are 'in-field' (between offshore platforms), and therefore it would not be unreasonable to say that the number of sectors to-and-from onshore helicopter terminals in the southern sector are considerable less than the total shown. The proportions illustrated by Figure 3 are consequently not a source of concern for the reliability of the sample. Similarly, the majority of offshore workers use the helicopter to go to-and-from their place of work on a two-week cycle, which is consistent with the returns from the survey shown in Figure 4.

Figure 4: Frequency of Flights



An objective of the survey was to collect sample data that would permit some estimation about the population as a whole. This requires that the sample be as random and representative as possible. From the results illustrated, there are no major indications of significant bias, and so the assumption is that the sample has the facility for valid and reliable estimation about the population as a whole.

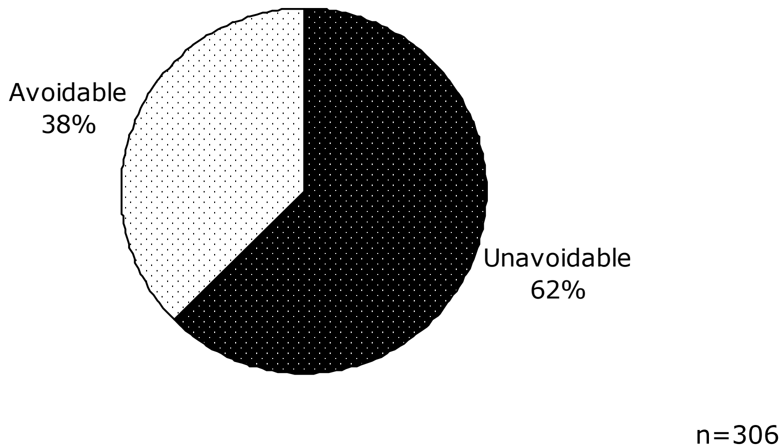
4.1.2 The Risk Preference

As discussed in the literature review, the standard practice for regulatory authorities is to use cost-benefit studies based on the expected number of 'lives saved' (or injuries avoided). These are most likely to achieve optimal results in a world that is generally risk-neutral. If this is an accurate assumption, then ignoring complex behavioural factors is justified, efficient and reasonable. If not – it is potentially a serious limitation.

The perceptions survey asked 5 questions that contribute to establishing the validity of this assumption.

The most direct question sought respondents' general attitude toward levels of risk in their daily lives: a) risk is unavoidable, but life is generally safe (a risk-neutral type response), b) risk is avoidable, and there are still too many dangers in life (a more risk-averse response). The results are illustrated in Figure 5. There is considerably less than a 5% chance that these numbers could be achieved by a random response, and (based on this response only) it is possible to be 95% confident that the proportion of the population showing any tendency toward the risk-neutral attitude lies between 56% and 67%.

Figure 5: Risk Attitude



This result on its own would seem to suggest that a generally 'risk-neutral' assumption is not going to produce a completely optimal result, because 40% of the population are unlikely to consider it justified. However, it is also possible that any 'risk-neutral' based decision will be acceptable enough to a large enough percentage of the population to work at some level.

There is also the possibility that this result only operates under normal conditions, and that even that section of the population not exhibiting a generally 'risk-averse' attitude will alter their 'demand function' (Savage, 1998) whenever a significant hazard is perceived. Such a phenomenon is suggested by Calabresi & Bobbitt's (1978) 'sufficiency paradox' theory, and similarly by Savage (1998), with a parameter termed a '*perception of preventive efforts undertaken*'.

Figure 6: Aircraft Grounding

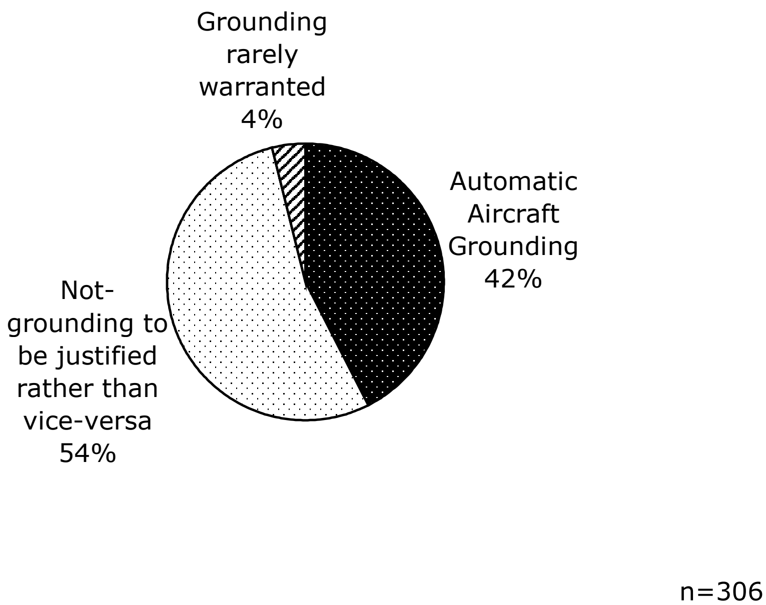


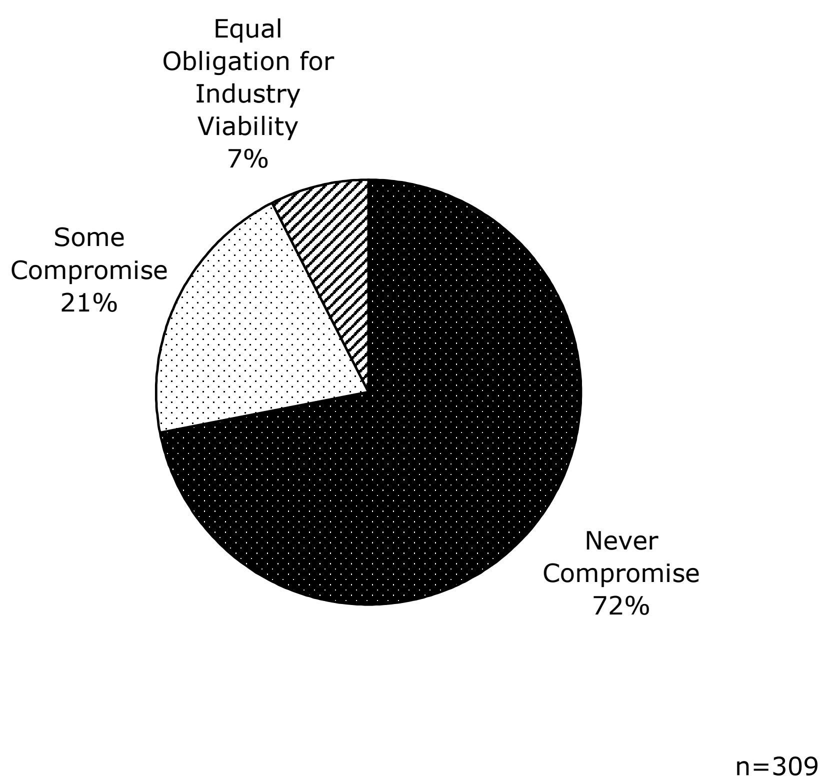
Figure 6 illustrates the results to a question about the level of precautionary approach respondents would prefer accident investigators to have following an accident. At present, it is considered a decision to ground all other aircraft of similar types should be the exception rather than the rule, which is the 'rational' response. In the circumstances of an aircraft accident, it would appear from these results that not only is a 'risk-neutral' attitude by respondents unlikely, it is more likely that the attitude is markedly 'risk-averse'. About 42 %, a similar proportion of those individuals who felt that there were too many risks in life (figure 5), considered that an absolute precautionary approach should be taken (i.e., ground all aircraft of similar type at the start of investigation). Another 54% considered that the aircraft should only continue to fly if there were good justification not to ground it. This makes a total of 96% of the sample (and, by extension, an assumed clear majority of the population) who would either already be 'risk-averse', or would alter their near 'risk-neutral' attitude toward 'risk-averse' following an accident.

This result appears to support theory stated in the literature review, and further suggests that the validity of an assumption that aggregate responses can be considered 'risk-neutral' is confined to a limited set of conditions.

4.1.2.1 Absolute Safety

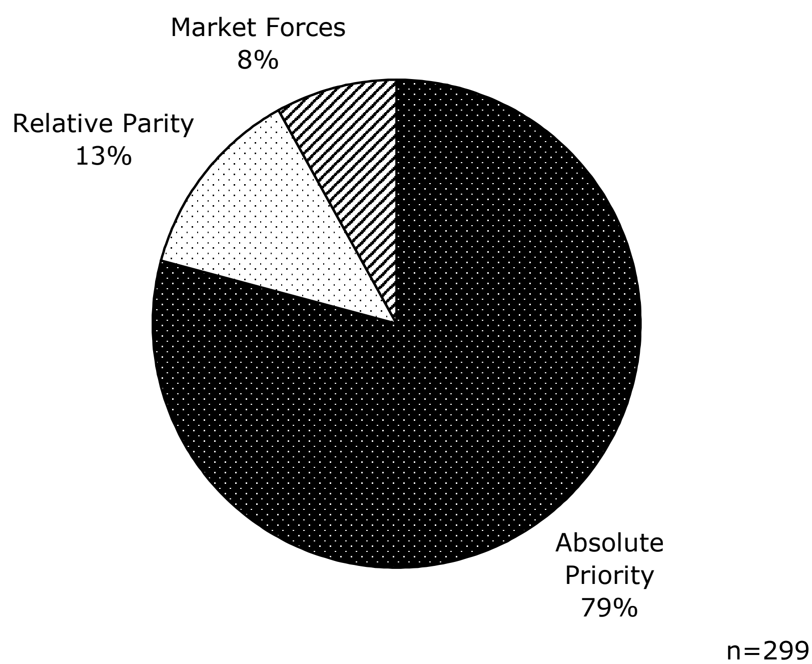
Where the results to the question illustrated in Figure 5 concerned an individual respondent's risk attitude, it was also important to establish the risk attitude respondents expected regulatory authorities to hold. The question posed was whether respondents expected safety regulators to: a) never compromise on safety in their actions (a risk-averse attitude or precautionary principle), b) make some allowance for cost in their actions (less precautionary), c) have an equal obligation to safeguard the financial viability of the industry. The results are illustrated in Figure 7.

Figure 7: Compromising Safety Regulations for Financial Considerations



Allied to this question, is a similar question to establish the attitude expected of companies. Response a) companies need to demonstrate an absolute safety standard, b) companies should only be expected to maintain an industry standard of safety (relative safety), or c) market forces are enough to ensure safety (laissez-faire).

Figure 8: Companies' Prioritization of Safety



The two charts, Figures 7 & 8, illustrate quite similar results. A significant majority (approximately 3 quarters) seem to expect absolute standards of safety from those with responsibility for the safety of third parties.

Whilst these are stated (or subjective) preferences by respondents, and any revealed preferences may prove less absolute; in conjunction, the results of all of the questions in this section do seem to present strong enough evidence to suggest that there is in fact an overall preference for a ‘risk-averse’ response to safety risks. If cost-benefit studies based on existing guidelines are to prove reliable and efficient (from a social-maximisation or public interest point of view) this aggregate risk-averse preference needs to be factored.

4.1.3 The Objectivity Assumption

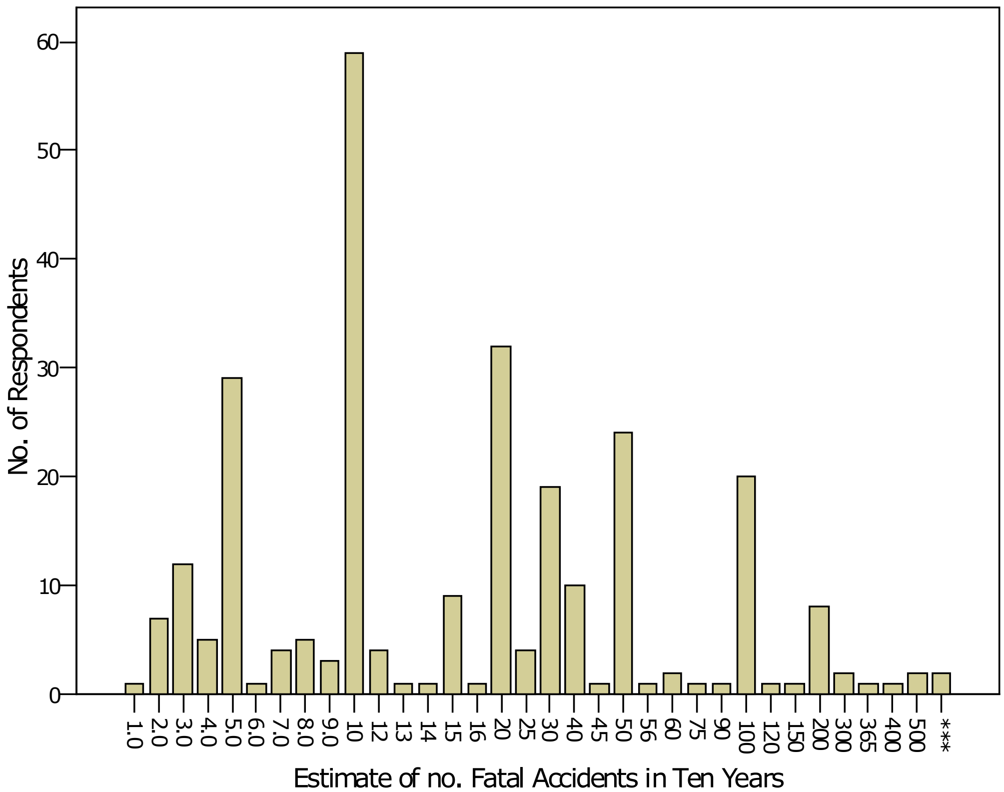
The second assumption, essential if cost-benefit analyses based on the guidelines of lives saved or injuries avoided are to prove optimal or efficient, is that the customer has the capacity to behave ‘objectively’. That is to say that the customer (or, passenger) has enough information to accurately assess their risk exposure and has the ability to put that assessment into context.

4.1.3.1 Statistical Safety

The survey asked two questions directly related to statistics. The first of these requested that respondents make a guess about the number of fatal accidents that have occurred in offshore helicopter operations around the world in the last ten years. In the second, respondents were asked to guess the percentage of these that were in the North Sea operations area.

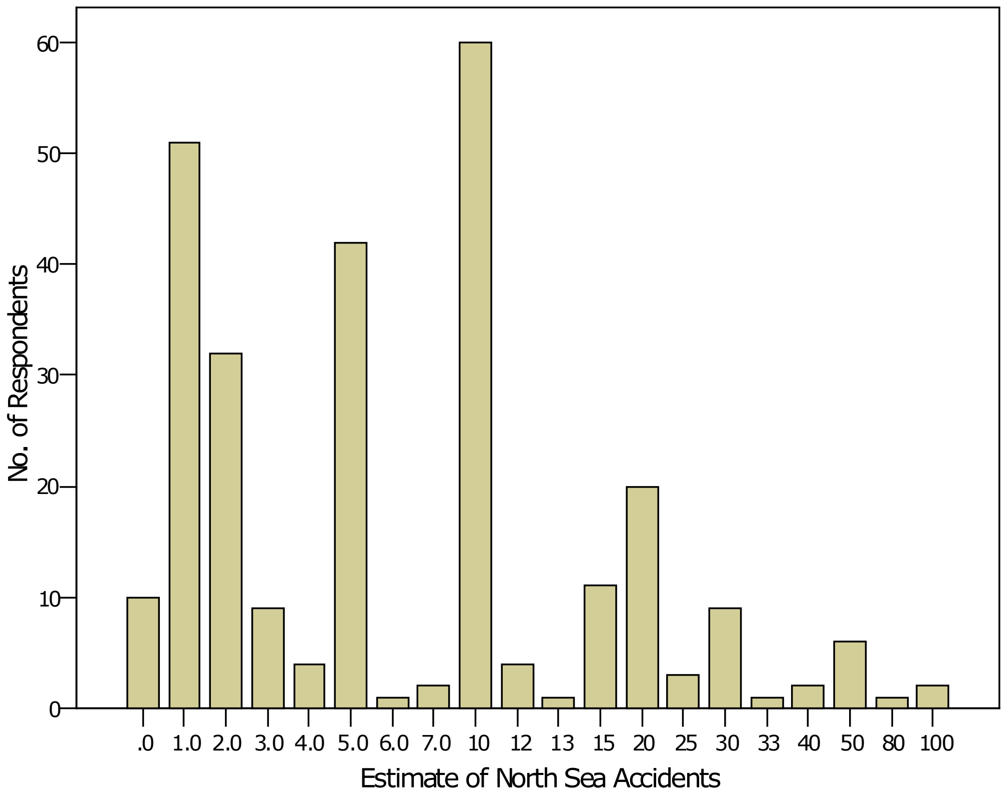
From data provided by the International Association of Oil & Gas Producers (OGP), a reasonable ‘objective’ estimate to the first question is anything between 50 and 70; and to the second question, the figure is around 0.6%, but an estimate of 1% would be consistent with the ‘objective assumption’.

Figure 9: Number of Worldwide Fatal Accidents in a Ten Year Period



The picture in Figure 9 does not appear consistent with a group of individuals who are in a position to behave 'objectively'. From the data provided by the survey, the number of respondents who actually gave a reasonably 'objective' estimate numbered just 25. Even if the extreme outlying answers (over 300) are excluded, the number of respondents who would have been expected to arrive at the 'reasonably objective estimate' by chance is anything between 13 and 28 (for the number in the sample).

Figure 10: Estimates of the North Sea Accident Record as a Percentage of Global Offshore Accidents



As well as further evidence for the lack of objectivity displayed by respondents in the first question (Fig.9); the results illustrated in Figure 10 lends support to the findings of other researchers who report that people will generally overestimate the probability of low probability events. Taking into consideration that the 1% estimate is actually about 60% too high, approximately 80% of survey respondents significantly overestimated the proportion of accidents on the North Sea.

The number of respondents who gave a reasonably objective estimate to both questions (and who could therefore be expected to conform with the assumption) numbered just 6, or 2% of the sample. When it is also taken into consideration that 3 of those respondents worked for the one of the helicopter operators, it is most unlikely that the population as a whole has the capacity to behave objectively.

4.1.4 Demand Attributes

There is existing evidence to suggest that the demand function will include a factor driven by the perception of safety (Calabresi & Bobbitt, 1978; Savage, 1998), and that this may well prove to be a step function (i.e., it's not acceptable, it's acceptable, it exceeds requirements or generates a surplus). Additionally, this factor will have an element created in part by the 'safety inputs' (Savage, 1998) undertaken by operators and/or manufacturers. Thus, potential customers will form judgements concerning the levels of 'due care' being taken. It is possible that this is the critical relationship in the overall economics of safety.

Anecdotally many stakeholder groups have their view about how passengers rate different aircraft attributes as determinants of safety. Manufacturers have an opinion that differs in some regards to that of the helicopter operator, which in turn differs from that of the oil company purchasing the service. All of which probably differ from the individual passenger travelling to and from work offshore. Some suggestions of these differences were available before the survey work started. The maintenance of interior fittings had long become a low priority for maintenance organisations (as it has very little consequence for the airworthiness of an aircraft). However, during the investigation conducted by Shell Aircraft International following the S76 crash in July 2002, it became apparent that some passengers formed an impression of the overall levels of care (or 'safety input') by how the aircraft looked inside.

The preliminary work for the survey presented further evidence about other anecdotal assumptions concerning passengers' attitude toward flying in offshore helicopters, and they too might not be valid. In particular, it is a common belief amongst the helicopter operators that the extensive pre-flight briefing given to offshore workers negatively colours their perception about the relative safety of helicopter operations. Even though the preliminary survey was a very small sample of potential respondents, there was strong evidence to suspect that this assumption could well be the inverse of the true state of passenger belief.

Given that more of these assumptions were likely to prove incorrect, a set of questions was included to discern and map some hierarchy of desirable attributes for an aircraft. In this way it might prove possible to make an informed guess as to what cues the respondents might actually be looking for to construct their opinion about the relative safety of that aircraft. For example, if a high relative score is given to ‘size’ or ‘location of exits’, it would be reasonable to look for other indicators of ‘dread’ (this would be consistent with the anecdotal assumption that passengers are left with a heightened sense of peril, or scared, following offshore safety training and the pre-flight briefing procedure). Alternatively, if passengers give a higher score to ‘maintenance of the interior’, it could be an indication that confidence in the helicopter operator plays a stronger part of the overall perception of safety.

Before giving weight to respondents’ preference for any particular aircraft attribute (question no. 11a, Appendix C), it was important to confirm anecdotal experience that the type of aircraft used by the helicopter operator is noticed, and is important to offshore passengers.

87% of respondents confirmed that they notice what type of aircraft they are flying in. Of those that stated that they did not, there is no clear common factor to group them. There is some suggestion that they are more likely to be younger, and to fly less often than the average, but it is not conclusive from the evidence in the survey.

The scores illustrated in Figure 11 were first calculated by assigning an ordinal score to each attribute according to where it was put in priority of 1 to 9, summing them and then dividing by the maximum possible score.

For Example:

205 respondents placed ‘Safety Record’ 1st = 205x9 = 1845
24 respondents placed ‘Safety Record’ 2nd = 24 x 8 = 192
18 respondents placed ‘Safety Record’ 3rd = 18 x 7 = 126
13 respondents placed ‘Safety Record’ 4th = 13 x 6 = 78
7 respondents placed ‘Safety Record’ 5th = 7 x 5 = 35
4 respondents placed ‘Safety Record’ 6th = 4 x 4 = 16
6 respondents placed ‘Safety Record’ 7th = 6 x 3 = 18
1 respondents placed ‘Safety Record’ 8th = 1 x 2 = 2
7 respondents placed ‘Safety Record’ 9th = 7 x 1 = 7

The total score for ‘Safety Record’ = 2319

The maximum score ‘Safety Record’ could have achieved

= The number of valid responses x 9 = 285 x 9 = 2565

If an index of 100 represents the maximum possible score, the actual score represents:

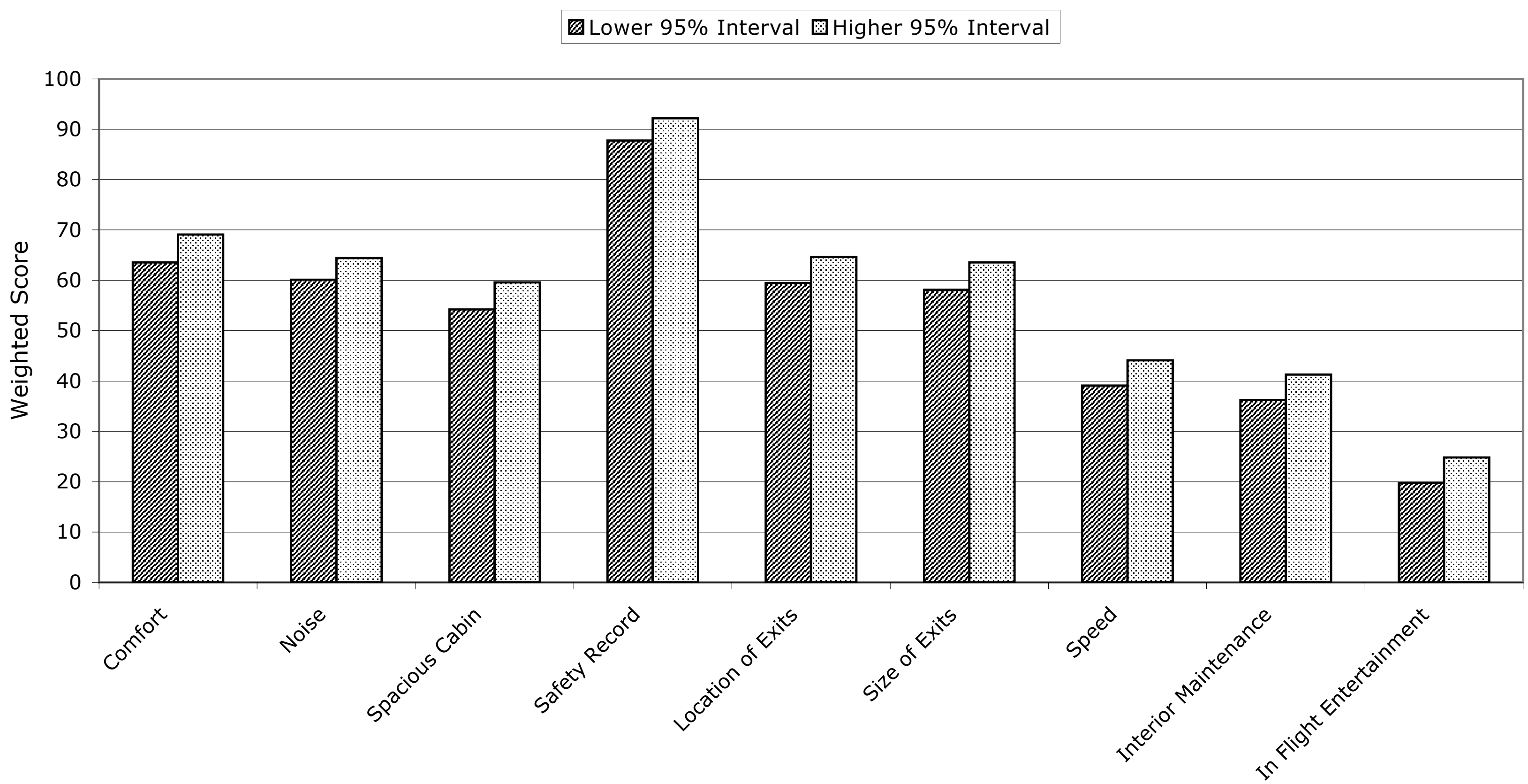
2319 ÷ 2565 = 90.4 points

To arrive at the range of scores expected from a survey of the population (95% confidence intervals), the scores for the sample were then subjected to resampling.

When looking at the data from just the pilots who participated in the survey, it is interesting to note that there is little overall difference, other than ‘noise’ gains slightly more prominence at an index of around 70.

Before attempting to draw conclusions from this data it is useful to look at some other results from related questions.

Figure 11: Hierarchy of Aircraft Attributes



4.1.5 Relative Safety

The survey asked that respondents express an opinion about the relative safety of offshore helicopter operations, compared to a benchmark of airline operations.

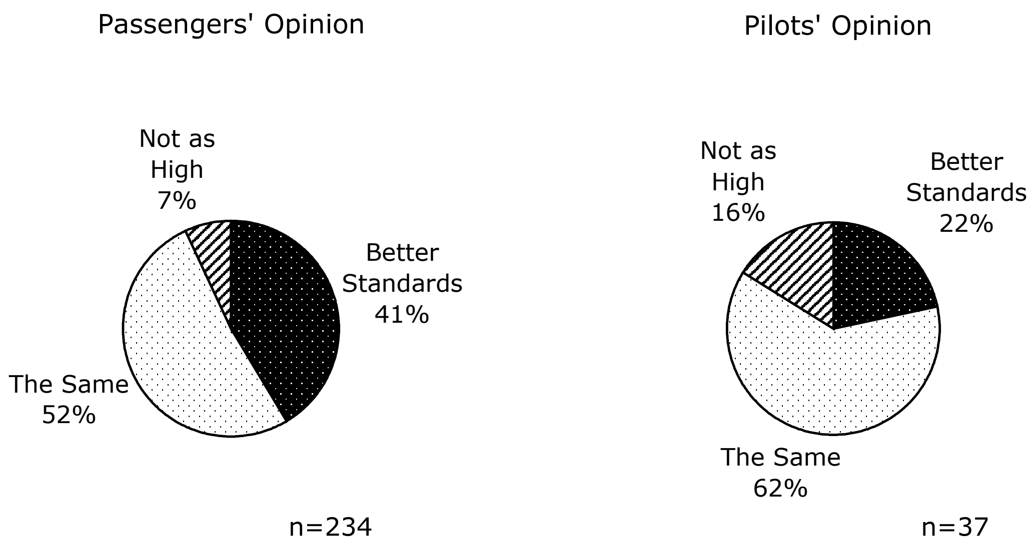
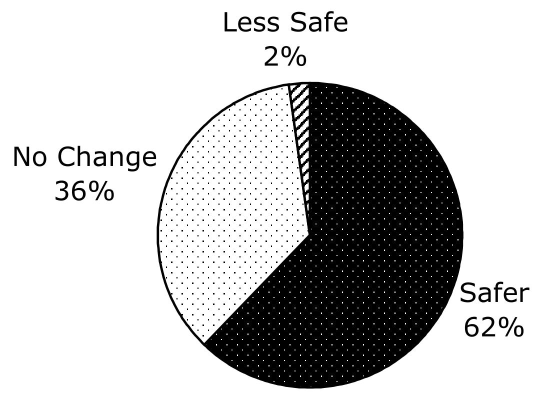


Figure 12: Helicopter Safety Standards as Compared to Airlines

The results would suggest that passengers generally have a good opinion about the standards of safety in offshore helicopter operations. In some regards, marginally better than professional pilots working for the helicopter operators (although the pilot sample is considerably smaller). Apart from adding further evidence undermining the assumption that consistently providing passengers with greater amounts of information (safety training and pre-flight briefing) has a negative impact on perception; the results support the notion that passengers have a view of relative safety. Additionally, if there are any particular doubts about offshore safety, the relativity of it compared to a standard of airlines is not likely to be the source.

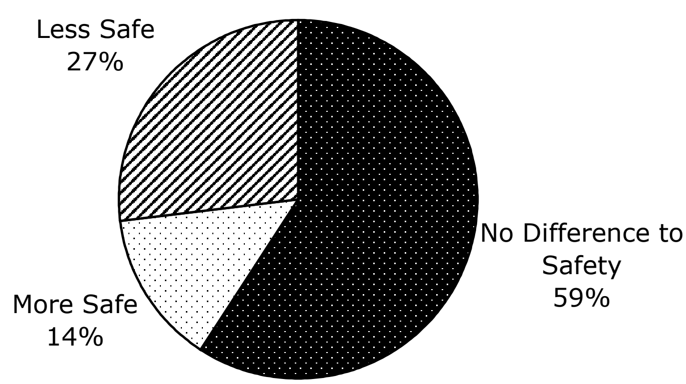
Two further relative comparisons were considered worth a question in the survey. The first, to check whether the safety of offshore helicopter operations is seen as an improving situation (Fig. 13); the second, to see whether there are any relative differences perceived due to the physical operating environment (Fig.14).

Figure 13: The Relative Safety of Offshore Operations Now Compared to Previously



n=307

Figure 14: The Relative Safety of Over Water Operations Compared to Over Land



n=302

The only difference between the responses of pilots compared to passengers is that a slightly higher percentage of pilots (21%) considered that over-water operations are safer than those over-land. However, it is particularly interesting to note both sets of respondents rationales for giving this answer originate from an opinion that Controlled Flight Into Terrain (CFIT) is a significant hazard, and that this is reduced by conducting over-water operations (revealed through additional comments, listed at Appendix D).

The fact that pilots give this answer is interesting, but not as surprising a result as the fact that many offshore passengers have such an extensive knowledge of the issue.

There are further indications amongst the comments contributed by respondents that the offshore workforce is a well-informed and sophisticated (from an aviation perspective) population. In providing comments, respondents were taking extra time and effort to complete the survey, and it is interesting to note that some 66% of the sample chose to do so. There were at least 35 comments (Appendix D) that lend support to the supposition that this body of passengers are well able to assess the relativity of offshore safety, if not in a strictly objective way at least on the basis of experience. For example:

- *"I once flew in the Gulf of Mexico in a Huey. That was less safe"*
- *"Flying in Gulf of Mexico, not as much preparation training"*
- *"Everything nowadays is aimed at safety, so they should be safer now than they have ever been realistically"*
- *"Over the years improvements made i.e., 2 pilots, improved lifejackets"*
- *"In the 1980s, I was aware of a number of crashes involving offshore travel, now they are almost unheard of in the North Sea"*
- (reference over-water operations) *"No granite clouds. Therefore less flight into terrain incidents. Only recovery after an incident is more awkward"*
- (reference over-water operations) *"It seems less hazardous to ditch in water but it presents its own hazards"*
- (reference over-water operations) *"Autorotation over land is safer, helicopters overturn on water"*
- *"In the early days passengers were not weighed, freight offshore was guessed & put on the flight"*

- *"Safety of aircraft is same over land or water but risks increase over water in event of ditching"*
- *"My perception is less safe* (over-water)*: although in reality I suspect there's probably no difference after surviving the impact whether you drown or survive the fire"*
- *"In the late 70's and early 80's the performance and equipment was sometimes marginal"*
- *"I've never felt unsafe flying, but recognise that there has been continual improvement with training, safety equipment & procedures which has increased safety"*

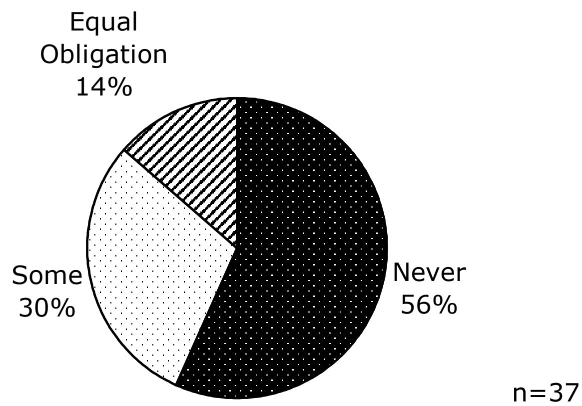
4.1.6 Paternalism

The offshore helicopter industry differs from many other types of aviation, and other sectors of the industry, in the number and type of restrictions and controls imposed on operating companies. The industry is subject to not only safety regulations imposed by government, but also many additional safety requirements imposed by the oil company that is contracting the service. These policies necessarily represent some element of paternalism by the organisations concerned. Some of it may well be viewed as self-interest, as it probably forms part of an overall package of measures to manage potential vicarious liabilities (particularly in the case of the oil companies). Regardless, safety regulations are used, and prevent or restrict the choices available to operating companies, who may act differently if the goal is maximising self-interest.

As safety regulation is such an important issue, it seemed logical to use some of the survey questions to establish: a) the extent to which safety regulation is perceived as being important, b) the type and scope of paternalism desired.

It has already been established from the results illustrated in Fig. 7 that 72% of the respondents stated that they thought that safety regulators should never compromise safety for financial considerations. However, that drops to 56% amongst the pilots, Fig. 15.

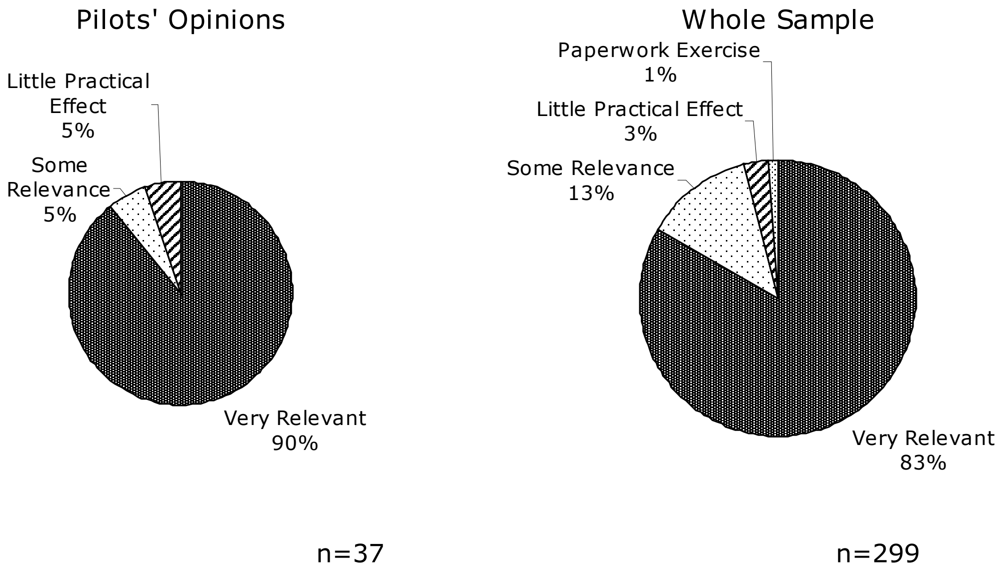
Figure 15: Should Safety Regulators Compromise
Safety for Financial Considerations (Pilots)



The extent to which passengers' and operator interests (in this case represented by Pilots' Opinions) may differ, and in certain circumstances compete, can reveal insights to much of the rationale sustaining arguments for a level of paternalism in the management of potentially 'tragic choices' (Calabresi & Bobbitt, 1978).

The issue is not just a straight forward question of whether there should or should not be safety regulation, but also one of alternative mechanisms, and levels of State involvement; therefore, using some 10 of the 32 survey questions (at least, in part) to fully explore this fundamental issue is justifiable.

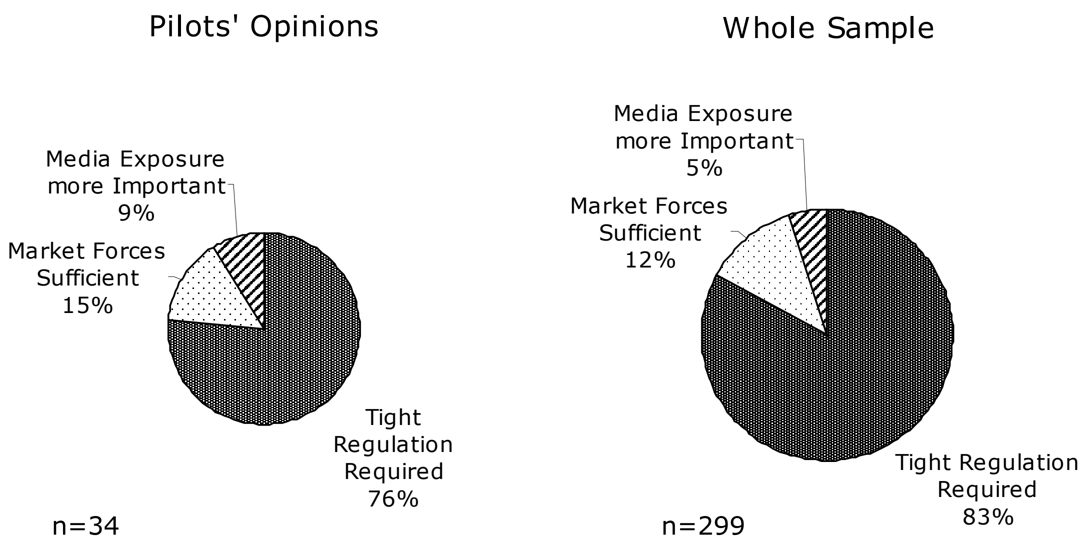
Figure 16: How Relevant the Standards of Safety Regulation are to Everyday Travel



It would appear that the paradigm of safety regulation as an instrumental part of the air transport system (and the wider transport infrastructure) is a generally accepted principle (fig.16).

However, it may be that safety regulation is merely accepted as a current state of affairs, rather than actually being valued as an effective means of achieving the objective of a safe transport system. This idea was explored by offering respondents two likely alternatives: a) the forces of competition in the market, b) the transparency and pressures offered by a modern media driven world (Fig.17).

Figure 17: Safety Regulation vs. Alternative Mechanisms (Media & The Market)



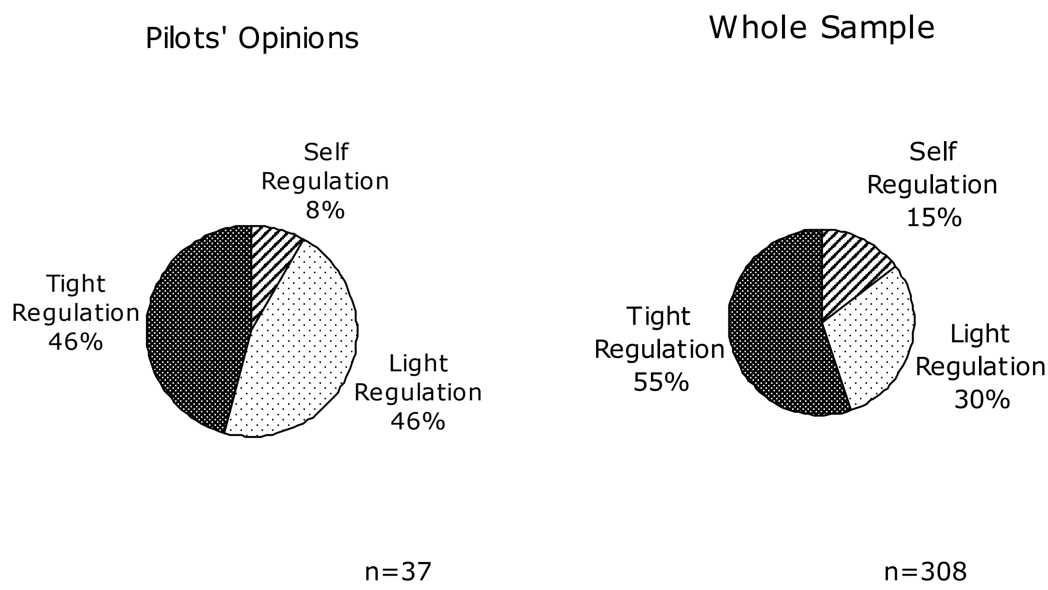
Although there would appear to be some marginal support for these alternative mechanisms, there remains a significant proportion of both operators and passengers who support the continued use of State safety regulation.

Despite the fact there is continued support from all parties for safety regulation, it is possible that some clearer differences would become apparent on the issue of how restrictive or stringent the regulation system should be (Fig.18).

For the sample as a whole, the proportion of respondents suggesting 'self-regulation' is reasonably consistent with the results in Fig.17 for 'market forces'. There is a slight variance in the case of the pilots, but that may just be due to some respondents expressing concern with the earlier reference to 'tight regulation'.

From the results illustrated in Fig.18, there would appear to be marginally more support for a system of 'tight regulation' amongst the sample as a whole, but it is interesting to note that 'light regulation' receives considerable support. Amongst the pilots, it would appear to be an even split of opinions.

Figure 18: Levels of Regulation Likely to Maximise Efficiency

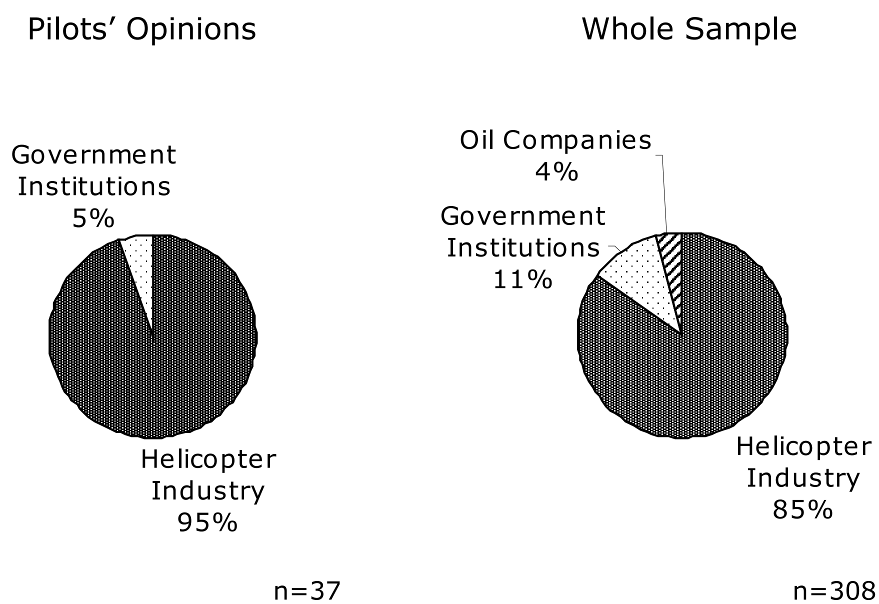


Of the whole survey, only one respondent gave consistently laissez-faire responses to all regulation questions. The respondent flies about 'once per year', aged '30-45', works in 'Exploration & Production', and has some responsibilities for helicopter management.

The issues of paternalism can be sub-divided into two general competences: 1) trust, 2) confidence. The results covered so far in this section are generally concerned with the former, but there is also the equally important issue of 'confidence'. As supported by theory discussed in the literature review, confidence is a competence driven by capability, both a technical capability (specialist knowledge) and a resource capability (funding and personnel).

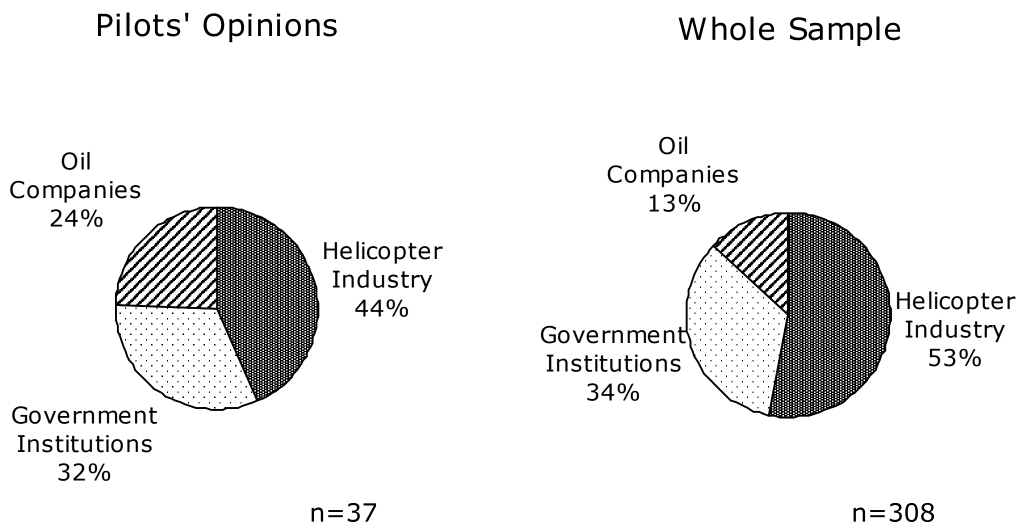
The respondents were asked three questions concerned with capability. First, respondents were asked to identify which organisation is best placed recognise effective safety (Fig.19). In other words, respondents were asked which organisation they thought would have the most personnel with the required specialist knowledge.

Figure 19: The Organisation(s) Best Placed to Recognise Effective Safety Measures



Given the resources devoted by various major transnational oil companies (in particular, Shell Aircraft International) to developing specialist knowledge in this field, it is interesting to note the results suggested by Fig.19. The overwhelming opinion is that the helicopter industry represents the group of organisations from which effective safety measures (improvements) are most likely to originate.

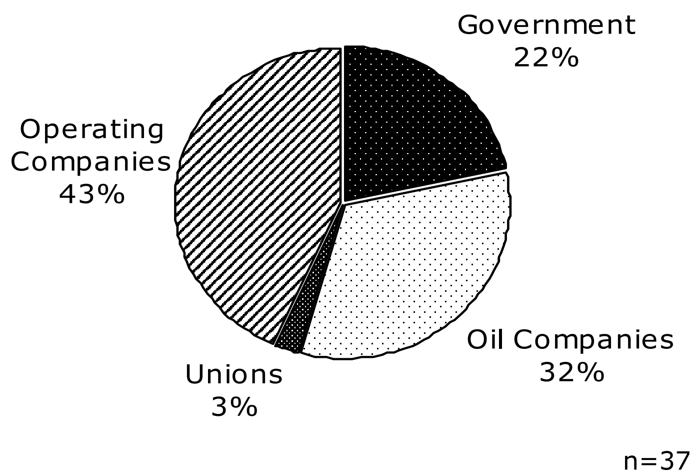
Figure 20: The Organisation(s) Best Placed to Ensure New Safety Measures are Adopted



However, when asked whether the same organisations should be trusted to implement new safety measures (Fig.20) (either as a result of conflicting interest or lack of resources), opinions are considerably more divided. Additionally, it is interesting to note that the operators (pilots' opinions, Fig.20) show less support for the capability of their own industry to implement new safety measures than the sample as a whole.

When the pilots were asked to give their opinion as to which organisation has done the most to drive safety innovation in offshore helicopter operations, the results were very similar (Fig. 21). Except that the relative positions of 'oil companies' and 'government' are reversed.

Figure 21: The Organisations Most Credited with Driving Safety Innovation (Pilots' Opinions)



The overall credit given to each group of organisations is illustrated in Fig.22, worked out for each group as follows:

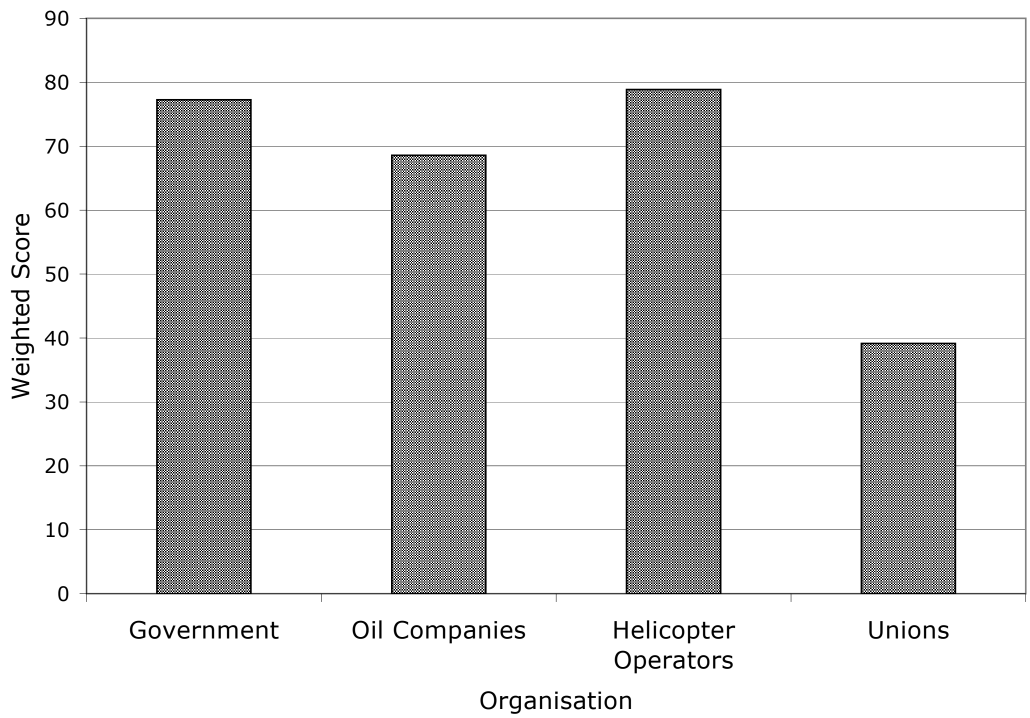
No. of 1st placings x 4
+ No. of 2nd placings x 3
+ No. of 3rd placings x 2
+ No. of 4th placings x 1

Divided by the maximum score = no. of valid responses x 4

= Weighted Score (index 100)

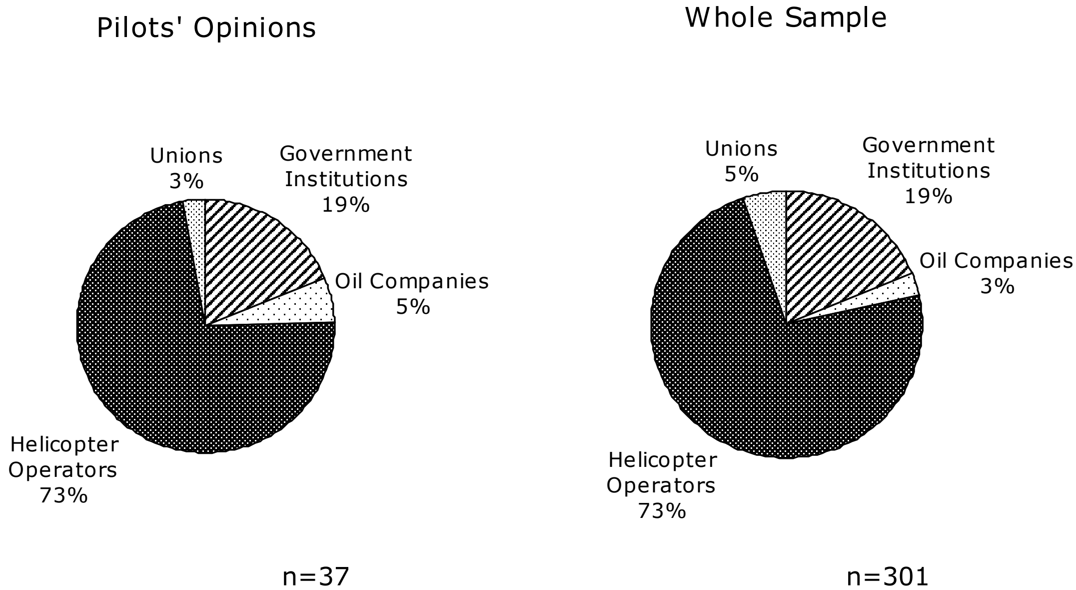
It is the fact that the opinion appears so evenly split about the effectiveness of government, oil companies, and the helicopter industry as drivers of safety improvement that is most noteworthy. Anecdotally, the oil companies have been providing the majority of the initiative and funding to drive safety improvements in this sector for some time. It was expected that at least the pilots' opinions would reflect that generally accepted position.

Figure 22: The Total Weighted Scores for Organisations Credited with Driving Safety



Despite these three groups (government, oil companies, & helicopter operators) receiving recognition for their role in promoting safety improvements; it is still very much the case that the helicopter operators are ultimately held responsible for the safety of helicopter operations (Fig.23).

Figure 23: The Organisation(s) with Most Responsibility for Ensuring Safe Helicopter Operations



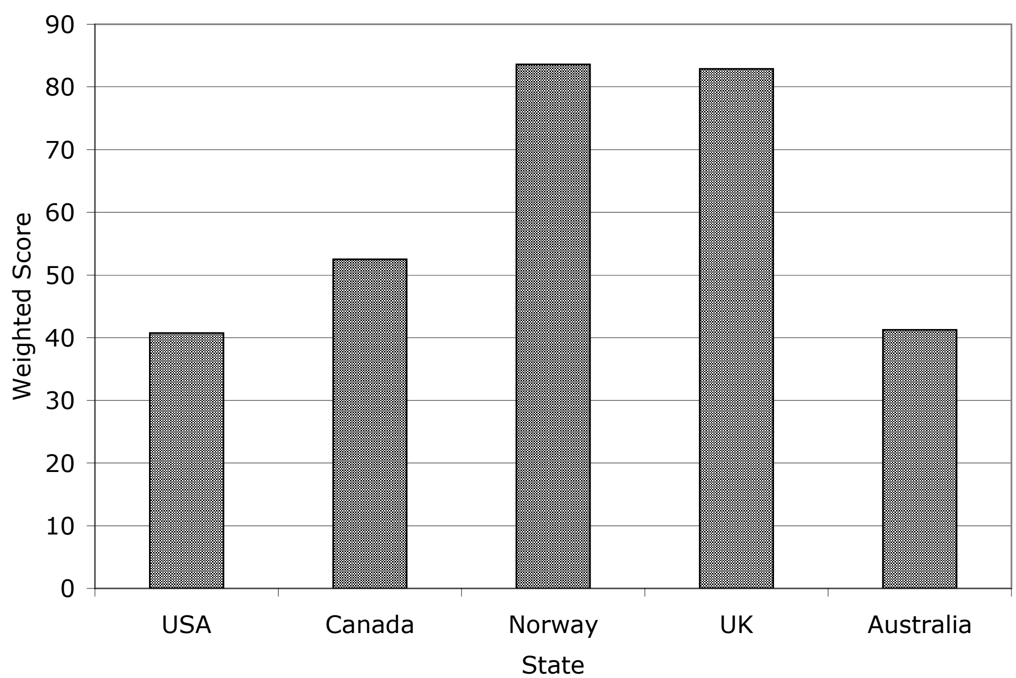
There were additional comments (Appendix D) that support the quantitative data. It illustrates the importance of paternalism in the management of safe offshore helicopter operations:

- *"Operators should be 100% sure that their aircraft are safe to fly anywhere"*
- *"At the first sign of a problem pilots return to base and sort it out"*
- *"As long as all relevant precautions are taken and appropriate training provided, I feel safe"*
- (Feeling Operations are now safer) *"It's not necessarily a feeling, more a realisation that risks are better managed now and the industry is more highly regulated (at least in the North Sea area)"*
- (Feeling Operations are now safer) *"More control and guidelines now as pre 1980's, i.e., Pilots' flying hours, wind and sea states, weight restrictions, better maintenance, more emphasis on safety"*
- *"I have full faith in pilots"*
- (Ref. Safety equipment)*"The companies must continue to develop new and innovative ideas for this market"*
- *"Have always been glad to fly in choppers with two engines. Regulation has ensured that risks have reduced"*

- *"Whilst I believe that safety has increased, in terms of awareness of risks associated with helicopter flight and protection provided in the event of a crash; I always feel safe. However, that may be due to placing my well-being into the hands of others when I have confidence in their professional skills"*

Respondents were also asked how they rated the relative standards of regulation in the North Sea operating area, compared with a range of others around the world. Using the same method as for Fig.22, the respondents rated the UK and Norwegian regulatory systems as being the most rigorous (Fig.24).

Figure 24: Comparing the Rigour of National Regulatory Standards, as Viewed by Respondents



4.1.7 Factors Affected by the Perceptions of Safety

It has already been well established that safety is a complex description of a multiple of factors. As an extension to some of these theories, it is a reasonable supposition that some factors can be generally classified as members of a group forming inputs to the equation, and similarly others as outputs.

Accordingly, the factors studied in the process of this survey fall into a group of 6 Inputs (Availability Heuristics, Knowledge, Power/Control, Expectations, Trust & Confidence), and 3 Outputs (The senses of Peril, Dread & Uncertainty).

4.1.7.1 Peril

The data illustrated in fig.11 shows a dominant preference for aircraft that have a good 'safety record'. This finding is substantiated by the result that 91% of respondents considered that: 'The accident record of any particular aircraft type is very important information, and should be generally available to the public at large'. The most closely related factor to this preference is the sense of 'peril', or more precisely a 'freedom from peril'.

A 'peril' related question asked whether respondents thought the safety training comprehensive, and whether (in their opinion) it was likely to improve their chances of survival. The question is important because much of the safety training concentrates on the emergency actions required when an aircraft ditches at sea, and the survival procedures required whilst awaiting rescue (Fig.25).

A small percentage of respondents amongst the pilots and passengers would appear to experience a strong sense of being in peril under these circumstances (3% in each case). Of the remainder, equal percentages of passengers and pilots consider the training comprehensive, but a higher proportion of passengers believe that their chances of survival are still likely to be low (63%). This is likely to translate into some feelings of peril whilst travelling for this majority.

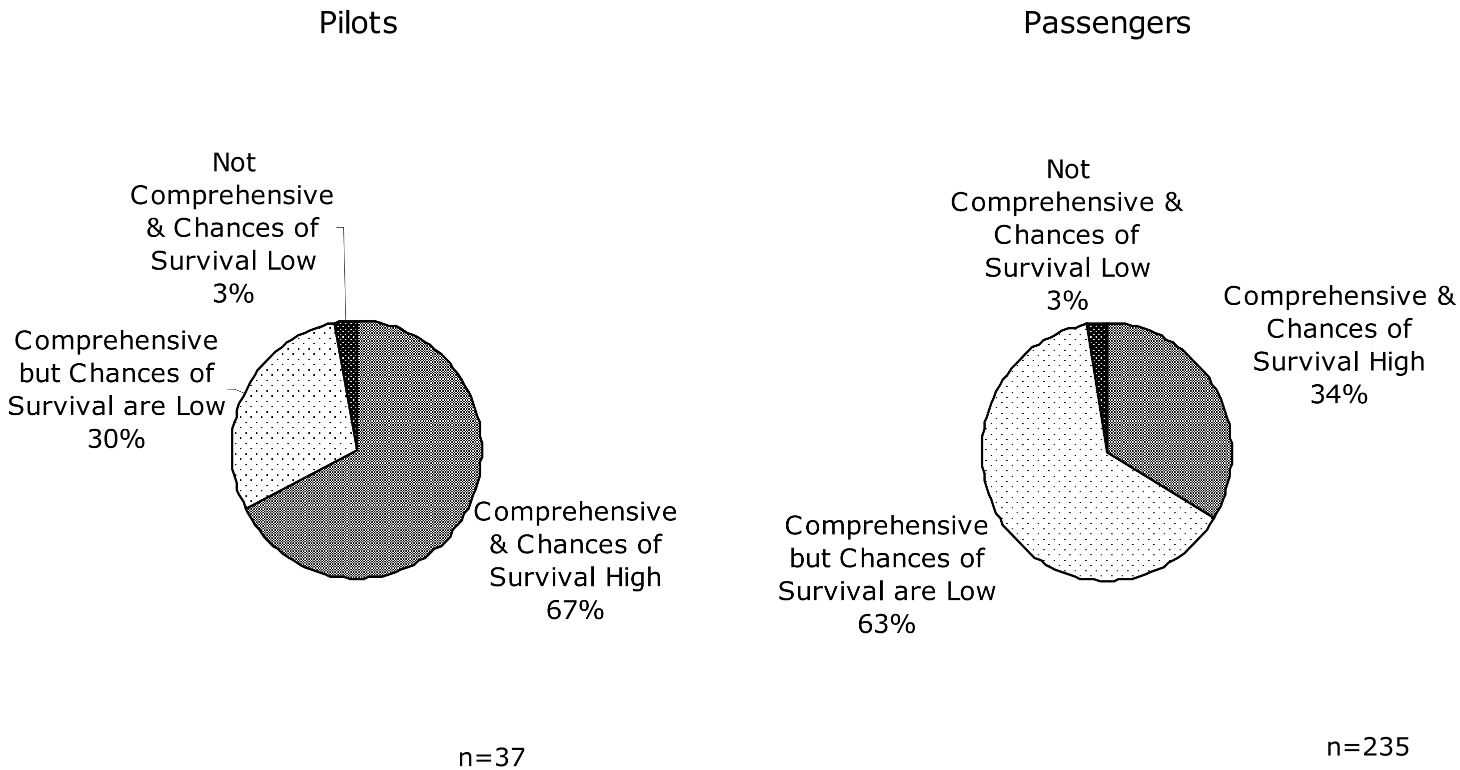


Figure 25: The Quality of Safety Training, and the Chances of Survival

As with other areas of investigation in this survey, there were a number of voluntary comments (Appendix D) submitted that add a qualitative dimension to the data already gathered. For example:

- *"Chances of survival in water crash virtually zero, but not much better over land"*
- *"Landing in an emergency on land is much easier than ditching to water at freezing temp."*
- *"Crashes are generally non-survivable whether over land or sea. Controlled ditching at sea is less safe due to likely sea states"*
- *"Helicopters can land anywhere, but are top heavy so flip in water"*
- *"With engine situated above pax (*abbreviation for passengers)*, upon impact (either land or water) it will drop on top of them regardless"*
- *"I believe if I crash I would be lucky to escape, but, if I survived, to then have to escape in water and wait on rescue – I don't think I have a chance"*
- *"Most people think when a chopper goes down no one will survive anyway!"*
- *"The important part is keeping the aircraft in the air!"*
- *"Helicopters are making several stops on different installations, resulting in more take-offs and landings, known to be the highest risk during flight"*
- *"High reliability of the aircraft has a greater importance than survival equipment"*
- *"Falling from height into water or land doesn't matter, you're still going to die"*

4.1.7.2 Dread

There no specific questions within the survey from which any quantitative assessments about feelings of 'dread' can categorically be made, although some questions may suggest it. In particular, it is probable that the 81% of respondents who answered that having the personal survival equipment supplied is more important than any discomfort wearing it may cause, did so in part due to feelings of unease brought on by the thought of having to evacuate the cabin whilst underwater.

The most significant evidence produced by this survey about the presence of 'dread' are the qualitative comments supplied by 66%

of the sample (Appendix D). There are at least 37 comments that have an evident element of 'dread' in them. For example:

- *"Mechanical faults cause stress. Bad weather conditions makes you worry a bit"*
- *"There is a secondary accident hazard in drowning if you were to survive the crash"*
- *"Risk of capsize, especially in bad weather, remoteness of rescue"*
- *"Capsize risk, ability to escape"*
- *"Flying in Chinook helicopters, 44 passengers with only 4 emergency exits, if the Chinook landed on the sea & turned over, there was no chance of escape"*
- *"Injured passengers may not escape from aircraft before drowning. Although impact may be greater on land, injured should survive"*
- *"Willing to use any item which increases survivability"*
- (Ref. Hazards) *"Water temp, ease of rescue, disorientation & panic"*
- (Ref. Feeling unsafe)*"Being in a helicopter with a large person next to you taking up half your seat and blocking the exit that they will not fit through"*
- *"You can't drown on land"*
- *"There is some good survival equipment out there (suits) the oil companies should spend some money and buy it"*
- *"Due to poor ergonomics and expanding waist sizes, in the event of submersion I feel in some seats there is little chance of escape or use of equipment, due to lack of space/movement"*
- *"Please make escape exits bigger"*

4.1.7.3 Uncertainty

It's a well established phenomenon that in a free choice people exhibit a natural inclination to avoid uncertainty and ambiguity. In economic terms, this will generally translate into a willingness to pay a premium to avoid or mitigate any uncertainty (insurance, etc.), or the juxtapositional situation of demanding some form of compensation to accept any uncertainty (hazard pay, etc.).

In aviation, it is often said that people prefer 'tried and tested' technology, and solutions to problems. Cobb & Primo (2003) listed one of six definitions of safety as "*the absence of unsolved crashes*".

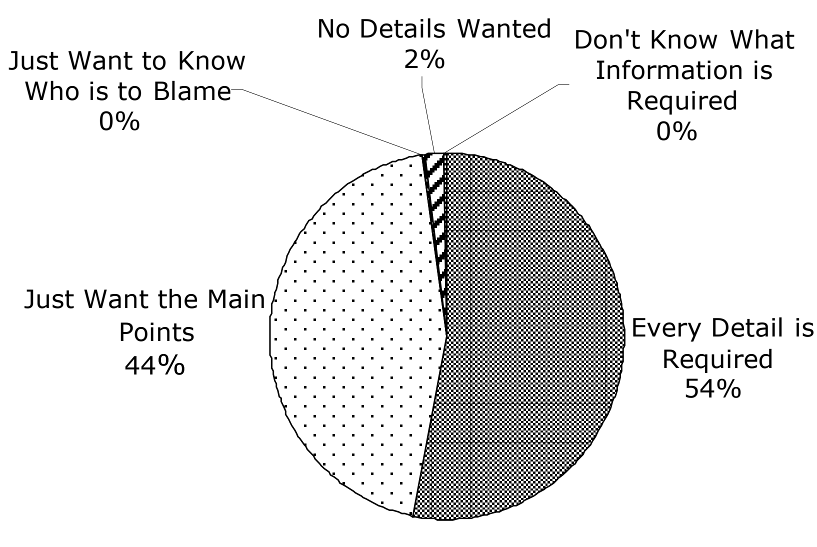
They stressed that: *"This safety definition is demanding for those involved, allowing for no failures or uncertainties on the part of investigators. No matter how long the time period, causes must be found and the public must be given a satisfactory answer"*(p.158). Two key questions in the survey explore the extent to which such a preference to avoid any uncertainty is observable, and measurable.

Reference the data illustrated in Fig.6, it has been established that 96% of respondents advocate varying degrees of precautionary approach following any accident. Only 4% of respondents considered a decision to ground an aircraft following an accident as 'rarely justified'.

The proportion of respondents that stated they would prefer to have every detail following an accident (54%) also supports the evidence that uncertainty could significantly influence the overall perception of safety (Fig.26).

Just the one respondent stated that they wanted to know 'who to blame'.

Figure 26: The Amount of Information That Should be Provided Following an Accident



n=299

4.1.8 Factors Affecting the Perceptions of Safety

As previously stated, the working assumption is that some factors studied in this survey form a group that are consequential of any perceptions of safety (Peril, Dread, Uncertainty), and others causative. Of those causative factors, some are so closely related to others that it is reasonable to consider them in conjunction, possibly as a sub-category of the other.

Using the material covered during the literature review as the basis of selection, there are six input factors selected for particular study as part of this survey: Knowledge, Availability Heuristic, Power (or Control), Trust, Confidence, and Expectation. However, availability heuristic is closely related to the broader category of knowledge, and the requirement for trust is inversely related to power (control). Metlay (1999) notes *"..there may be an important relationship between trust and power. When power is distributed evenly, trust is not essential, particularly when exchanges take place over short time horizons and involve clear feedback measures.. ..However when power is distributed unevenly, the trust relationship is more essential for the more dependent and less influential party"* (p.114). Similarly, it is useful to consider trust in conjunction with confidence, as, although separate, there is a wealth of past material to suggest these two factors are inherently linked (Metlay, 1999; Lazaric & Lorenz, 1998).

Therefore, the following sections of the analysis are organised accordingly.

4.1.8.1 Knowledge

For the purposes of this survey, the tests of knowledge are the levels of awareness exhibited about the dangers and hazards presented by offshore helicopter travel, and the deficiencies and limitations in the present systems to manage them.

It has already been established that any knowledge used by respondents to form perceptions of safety are unlikely to be objectively based (Fig.9 & Fig.10). However, that result is not the same as saying the survey respondents have an unsophisticated knowledge of the hazards faced, or the safety management system.

The result that 98% of respondents would expect, or demand to know at least the main points of any aircraft accident investigation report (Fig.26) is also supported by the comments added by some respondents (Appendix D), which exhibit a high degree of technical awareness. For example, some selected comments from passengers (i.e., not pilots or helicopter engineers):

- *"I have always been glad to fly in choppers with two engines. Regulation has ensured that risks have reduced"*
- "*The vibration monitoring equipment is a major factor in preventing critical failures along with the constant improvement in material specifications"*
- (Ref. Feeling safer) *"Additions of HUMS to aircraft, advances in condition monitoring & lessons learned from many years of operation"*
- "*Helicopters are making several stops on different installations, resulting in more take-offs & landings, known to be the highest risk during flight"*
- *"Because of the stinginess of oil companies & government apathy, the flotation devices are still fitted in the wrong place, allowing aircraft to turn turtle in the slightest seas. These devices should be fitted where the weight is, i.e., engine & gearbox"*

In total, there were 58 comments from the passengers amongst the sample that exhibit some higher levels of knowledge about technical or operational helicopter matters. That equates to just over 20% of the respondents who voluntarily added such a comment to their questionnaire return.

When asked about how much information helicopter operators should have to publish about less severe safety matters (non-accident data), the results were as illustrated in Fig's. 27a & b. Where 'third party oversight', in this context, is an unspecified but trusted institution(s) operating in the passengers' interests.

This is a subject about which there could logically be some variance of opinions between passengers and helicopter operators. So, for comparison, Fig.27b shows the results from the pilots' survey returns only.

Figure 27a: The Amount of Information About Safety Related Matters That Should be Published by Helicopter Operators

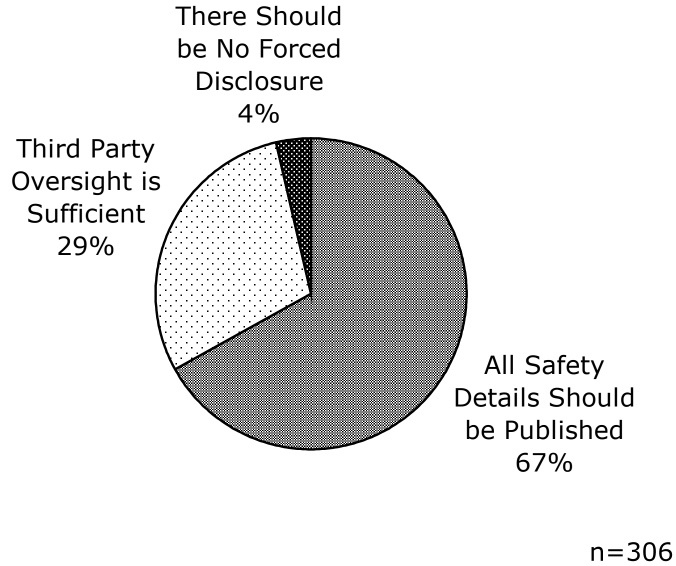
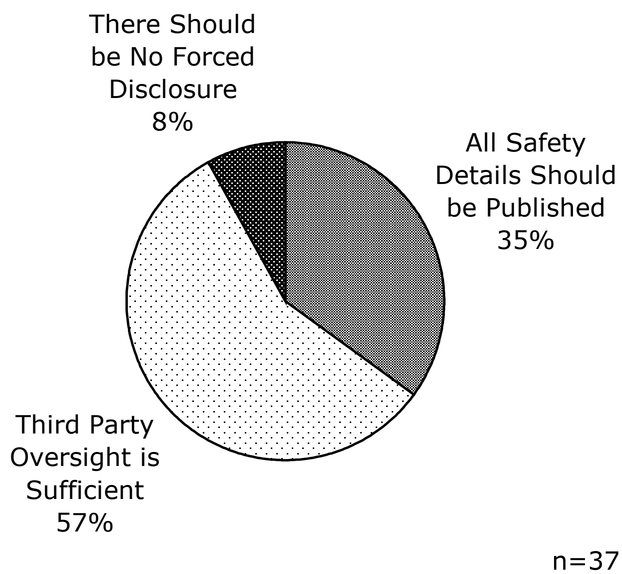


Figure 27b: The Amount of Information About Safety Related Matters That Should be Published by Helicopter Operators (Pilots)



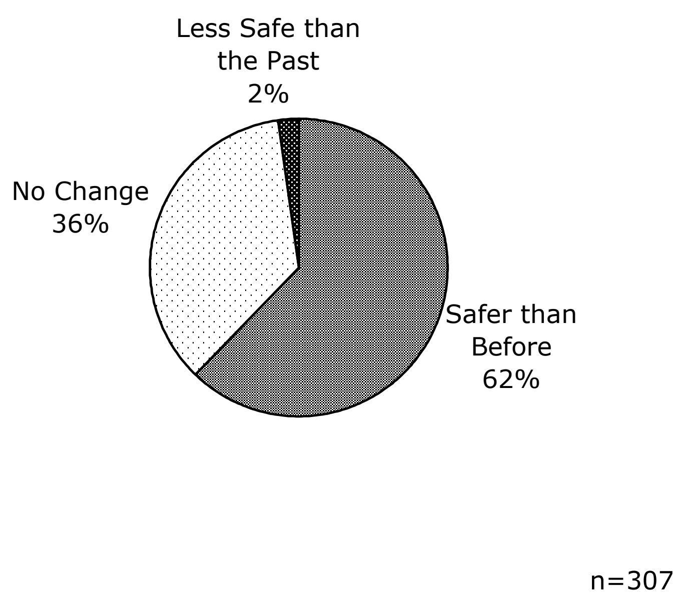
It is reasonable to conclude that the respondents in this survey have an interest in the subject matter of helicopter safety, and have the capability to understand many of the issues. From the data illustrated in Fig.27a, a significant majority consider it important to have information available on which to form their own opinions (67% stating that all details should be published). Of the helicopter operators (represented in this sample by the pilots), there is an apparent reluctance for such an extensive level of transparency (57% stating that third party oversight is sufficient).

Analysis of the influence knowledge has on perceptions of safety cannot be complete without considering the role of heuristics, and, in particular, the availability heuristic (Slovic, 2000).

4.1.8.2 Availability

The survey had two questions primarily directed at trying to generate information about the influence of the availability heuristic. The first question (fig.28) asked respondents to assess whether helicopter operations were now safer than before, followed by a supplementary question which asked them to state whether they recalled the time they felt less safe (if they had stated that operations were now 'safer').

Figure 28: The Relative Safety of Helicopter Operations Today



Of those respondents that stated that operations are now safer (62%), 38% were able to recall a time when they felt less safe.

As the most recent accident, it was assumed that the most likely evidence concerning the influence of the availability heuristic (or bias) on passengers' perceptions would originate from the accident to a Sikorsky S-76 helicopter, G-BJVX, off the Norfolk coast, 16th July 2002.

Of the 27 comments given (Appendix D) that have elements of an availability heuristic, there were indeed 6 specific references to the S-76 accident as an influence. Interestingly, these comments indicate that the availability heuristic is not necessarily going to negatively impact the perception of safety; occasionally it appears to have a positive impact. The six comments are given below:

- (Ref. Feeling less safe in the past) *"Following Shell's S-76 crash off Leman in 2002. The industry continues to learn from accidents and investigations which continuously improves safety"*
- *"I was onboard the Santefe Monarch in 2002 when the S-76 went down, so for a while I thought about safety much more"*
- (Ref. Feeling less safe in the past) *"Helicopter crash, S-76, no real reason found why"*
- *"But felt **safer** just after 'downed' chopper about 2yrs ago, as I knew everyone would be more focused on maintenance/safety"*
- (Ref. Feeling less safe in the past) *"Because of 76 accident"*
- (Ref. Feeling less safe in the past) *"Prior to lightning strike on blade incident which was a factor in the incident at Norwich"*

However, unexpectedly, there were also 7 comments with equally significant references to an accident nearly twenty years ago, that of the Chinook helicopter, G-BWFC, 6th November 1986 (45 fatalities).

- (Ref. Feeling less safe in the past) *"After any incident, but mainly after the Chinook incident off Shetland, which I was close to at the time and knew a number of persons involved"*
- (Ref. Feeling less safe in the past) "*The time they flew Chinooks"*
- "*Flying is now safer. There are still helicopter incidents, near misses, technical faults, and fatal crashes still occur. But, in the past, helicopters have been used which were*

uncomfortable, noisy & generally hated by the workforce. I refer to Chinooks, and although numerous complaints were made, it took a fatal crash to take them out of service. Generally concerns are now acted on"

- *"I did not feel safe flying in the Chinooks"*
- (Ref. Feeling less safe in the past) *"When flying in Chinook helicopters"*
- (Ref. Feeling less safe in the past) *"Used to fly Chinooks, was on Cormorant Alpha crew when chopper went down"*(AS332 accident, 14 March 1992, 11 fatalities)
- (Ref. Feeling less safe in the past) *"Flying Chinook helicopters, 44 passengers with only 4 emergency exits. If the Chinook landed on the sea & turned over, there was 'no' chance of escape"*

The strength of feeling about the Chinook suggests that the longevity of any availability heuristic is, in some part, dependent on the dramatic nature of the disaster concerned. Between 1986 and 2005, there were 5 other fatal accidents involving offshore helicopter operations (excluding S-76, G-BJVX), and yet there is just the one reference to any of these.

Of the remaining 10 comments that have distinct elements of availability heuristic, 4 have a positive effect. These comments describe how the respondents' cannot readily remember any helicopter incidents, and how they therefore feel safer.

Other comments refer to specific occasions when respondents were onboard particular aircraft and, because of some change to the normal situation, subsequently felt less safe. For example:

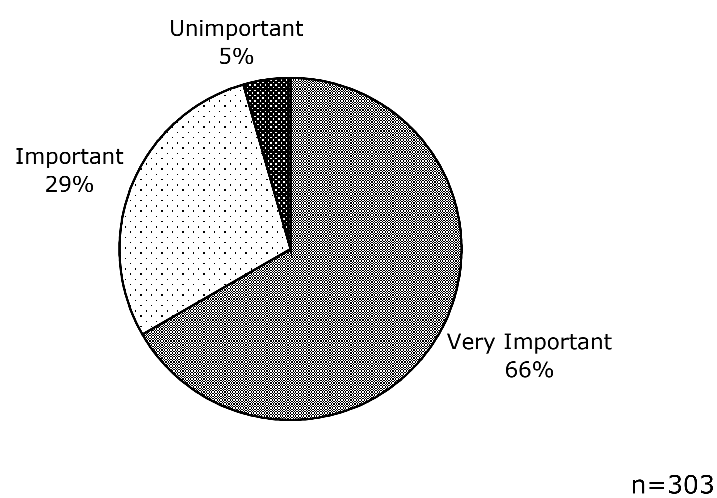
- *"After landing onshore, aircraft jammed one undercarriage wheel in drain cover on apron. Pilot attempted to use lift from rotor to free the jammed wheel without disembarking passengers first. Aircraft tilted heavily to one side"*

4.1.8.3 Power

The relationships between the acceptable levels of risk and the associated levels of power or control is both well documented and generally accepted. The purpose of this survey was thus not to try to describe such relationships, but rather to make some estimate of the respondents' perceived levels of control over the risks they face in helicopter travel.

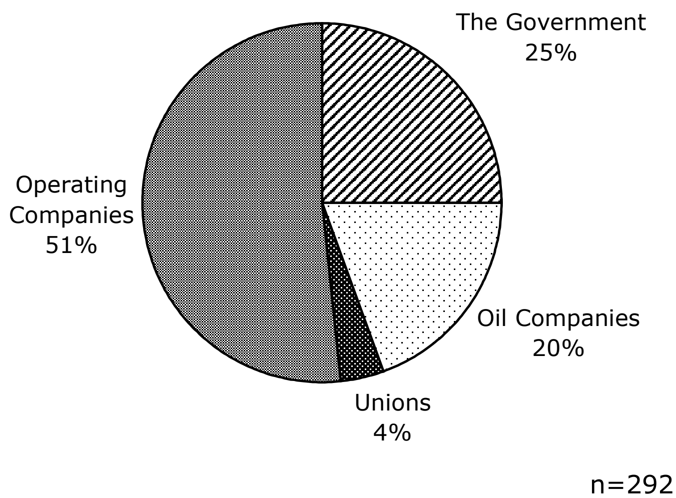
The survey included a two part question, asking respondents to state how important it is to be able to express an opinion about helicopter safety issues to responsible authorities, and whom it was considered most important receives that feedback (Fig.29 & Fig. 30).

Figure 29: The Importance of Being Able to Express an Opinion About Helicopter Safety (Data from Passengers)



Logically, there is little need (or, at least, not a strong need) to express an opinion if someone is in a position to control risk factors for themselves, or, alternatively, if the risks are not significant enough to be concerned over. Therefore, 66% of passengers in the sample stating it 'very important' to be able to express their opinions to a responsible authority about helicopter safety matters would seem to suggest that they do not have a great sense of control or power over their safety.

Figure 30: The Organisation it is Most Important to be Able to Express an Opinion to (Data From Passengers)



The main point of asking the supplementary question of whom it is most important to direct this feedback via (Fig.30) is to compare the result with the earlier data of who is most responsible for safety (Fig.23). One possible conclusion is that although 73% of respondents hold the helicopter operators responsible for safety, a significant number consider it important to have an intermediary or agent to represent their interests (oil companies, government, and unions totalling 49% in Fig.30, as opposed to 27% in fig.23).

The pilots gave slightly different responses: 81% stating it is 'very important' to be able to express an opinion, and 70% stating that feedback should be directed to the helicopter operators. However, it is difficult to make a direct comparison with the passengers, as the purpose for giving feedback is likely to be different. From anecdotal experience, in the case of the pilots it is less likely to be connected with any notion of control over risks, and more to do with general terms of employment.

There was some additional material provided within the comments (Appendix D) that support the estimate of perceived power (control) as low. For example, there were a number of comments that express concern that other passengers on the aircraft (over whom the respondent submitting the comment has no control) will hamper emergency evacuation:

- *"For a man over six ft. two wearing all the equipment, I don't believe he could escape, and no way could he assume the crash position (all helicopters need 3" more leg room)"*
- (Ref. Hazards of evacuation) *"panic"*
- (Ref. Feeling less safe) *"Control on overly large/obese passengers"*
- (Ref. Feeling less safe) *"Being in a helicopter with a large person next to you taking up half of your seat and blocking the exit that they will not fit through"*
- "*I am concerned, however, that some survival equipment (airpocket) may hinder my exit in an emergency"*
- *"18 people would be hard to exit in a crash"* (Note: 18 passengers is a full load on a AS332 Super Puma helicopter)
- *"You seem to have to wear more and more clothing & equipment every year, making escape from helicopter more difficult"*
- *"Please make escape exits bigger"*

4.1.8.4 Trust & Confidence

Given the scope of material covered by the survey, it would be a challenging prospect to distinguish the complementary qualities of trust and confidence, however distinct the meanings of the two words might be. A decision had to be made at a relatively early stage in preparation for the survey as to whether any confusion of the two would alter the overall result of the study. The length of the survey needed to be constrained by the practicality of achieving an average completion time of 10 to 15 mins, because this was deemed to be the maximum time passengers would have spare, or be generally willing to give, whilst waiting in the helicopter terminal. Therefore, these nuances, however interesting, had to be placed in lower priority to other objectives.

In a complex world, individuals rely on institutions to simplify transactions that are either too infrequent to justify building up the necessary specialist knowledge, or so multifaceted that it would exceed their available resources. For these institutions to fulfil this agency role, they must display both the qualities of trustworthiness and competence (confidence). In the environment of offshore helicopter operations, this becomes most critical when a failure of safety management is highlighted by an accident. Hence, there are two questions in the survey constructed to establish the relative importance of various institutions within the framework of the system under these circumstances.

The survey asked respondents to state who they would most trust for information about an accident, followed by who they would most trust for assurance that it was safe to fly again (fig.31).

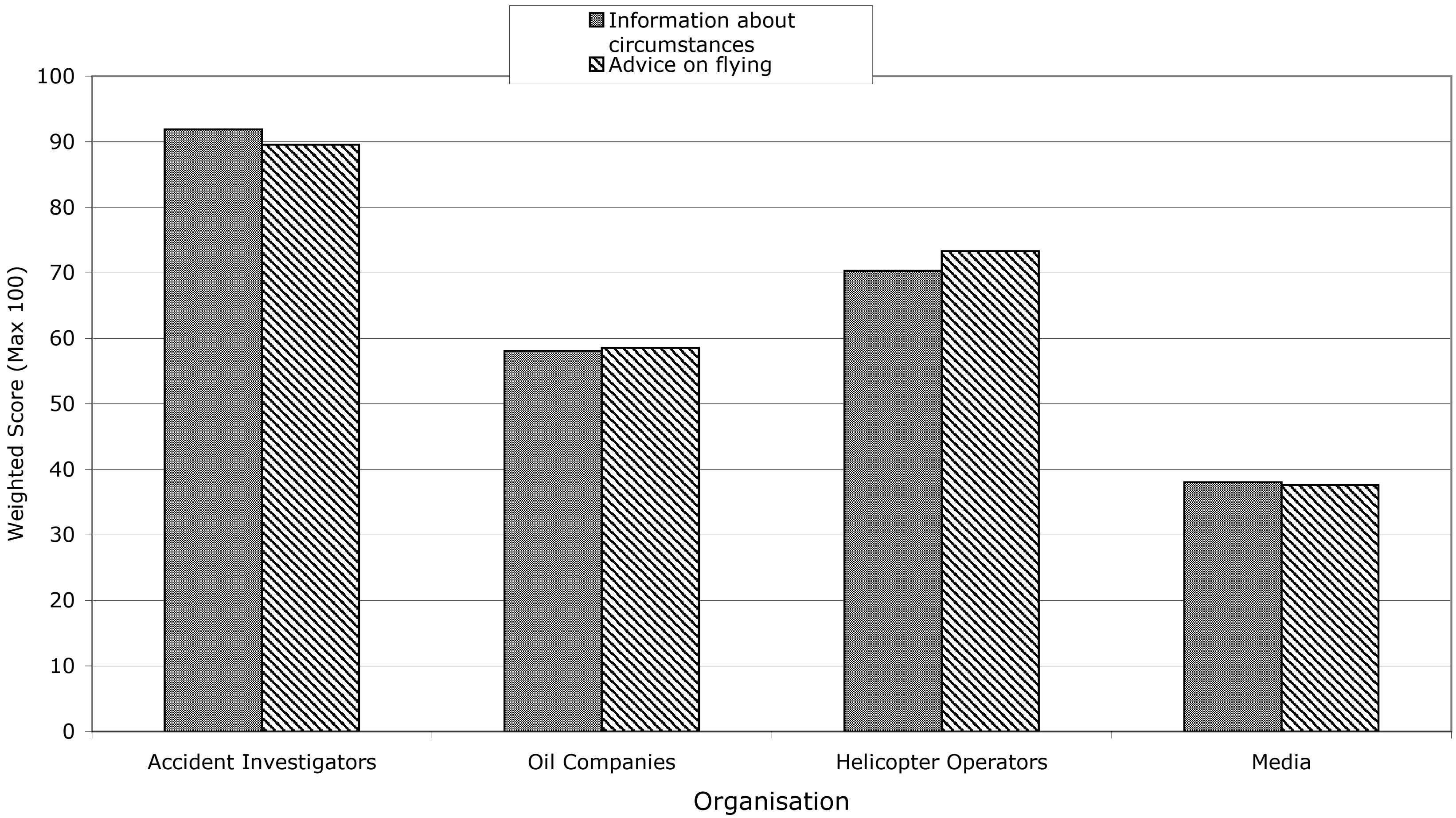
For Example, the weighted scores for the 'Oil Companies':

Placing	Trust for Information About the Circumstances of the Accident	Trust for Information About the Safety of Flying Again
1st	14 x 4	18 x 4
2nd	58 x 3	53 x 3
3rd	112 x 2	115 x 2
4th	20 x 1	19 x 1
Total	474	480
Maximum	204 x 4	205 x 4
Score	58.1	58.5

This relates to the notion that Cobb & Primo (2003) had in making one of the six definitions of safety the 'absence of unsolved crashes'. As it can be seen, in the opinion of respondents to this survey, it is the key role for government to ensure that accidents are solved, and to sanction the resumption of flying operations.

It is also interesting to note that a small number of respondents (7%) stated that they would trust the media most for information on which to frame their opinions. Given the size of this sample, it has not been possible to accurately profile these respondents. At first, it looked as if this phenomenon would be typified by a younger age group (under 30), but as the survey progressed that was later proven an unreliable indicator (on its own). Although not a large enough response to have a significant affect on this survey, understanding the drivers for this response could have some interesting implications, especially on the much larger scale of airline travel.

Figure 31: Trust & Confidence Held by Organisations in the Event of an Accident



As made clear above, it was not feasible to measure the qualities of trust and confidence independently. However, that did not eliminate the possibility that some distinctions would be evident in the comments volunteered by respondents to the survey.

There were comments that suggest that the quality of aircrew training, and the confidence it engenders, is an important factor for some passengers:

- (Ref. Feeling safer) *"I have full faith in pilots"*
- (Ref. Feeling safer) *"I always feel safe. However, that may be due to placing my well-being into the hands of others when I have confidence in their professional skills"*
- (Ref. Feeling safer) *"Everyone in the business is older now"* (meaning more experienced in this context)
- (Ref. Feeling safer) *"Standards of offshore heli-crew competency & standard of operating company's maintenance & operations"*
- (Ref. Feeling safer) *"We as helideck crew and as helicopter passengers feel confident in the helicopter operators, as this is the safest way to get from offshore to onshore each trip"*
- (Ref. Feeling safer) *"Services are far more professional than 70's and helicopters newer"*

There also some comments that highlighted the importance of trust:

- (Ref. Feeling safer) *"At the first sign of a problem pilots return to base and sort it out"*
- (Ref. Feeling less safe) *"Because of the stinginess of oil companies & government apathy the flotation devices are still fitted in the wrong place,.."*
- *"But felt safer just after 'downed' chopper about 2 yrs ago, as I knew everyone would be more focused on maintenance/safety"*
- (Ref. Feeling safer) *"I do feel they always err on the side of safety"*

4.1.8.5 Expectation

Expectation is another factor that is challenging to assess quantifiably. However, from the data gathered in relation to other topics, it is possible to conclude that there are high levels of expectation amongst the survey sample concerning both helicopter operators and the regulatory authority behaviour.

Looking at the data illustrated in Fig.8 and Fig.23, with 79% of respondents stating that companies are expected to make safety an absolute priority and 73% stating that helicopter operators are most responsible for safe operations, it suggests an expectation that the helicopter operators will be held accountable for their activities.

From Fig.7 and Fig.24, a conclusion can be made that respondents expect the UK regulatory authority to maintain the highest possible standards of regulation; with 72% stating that regulators should never compromise on safety when making decisions, and the UK being rated as having the highest standards of regulation amongst the major offshore helicopter operating regions (equal with Norway).

Corroborative data for these conclusions is also evident amongst the comments supplied (Appendix D):

- *"No person should have to put their life unnecessarily at risk in order to carry out their job. Risks should be eliminated or, if that is not feasible, controlled and closely monitored"*
- *"Safety should be paramount whether over land or sea"*
- *"Everything nowadays is aimed at safety, so they should be safer now than they ever been realistically"*
- *"The same measures should be taken to ensure safety, whether over land or water – the highest measures"*
- (Ref. Feeling less safe) *"Overseas"*
- (Ref. Feeling safer) *"Stricter regulations"*
- *"Whether flying over land or not, safety should not be compromised"*

There are also comments that suggest that it is an expectation that safety improves with newer technology, and experience:

- *"I would like to think helicopter travel is getting safer every year"*

- (Ref. Feeling safer) *"Additions of HUMS to aircraft, advances in condition monitoring & lessons learned from many years of operation"*
- (Ref. Feeling safer) *"Mainly because of the continuing safety researches"*
- *"Improvements in technology allow improvements to safety programs"*
- (Ref. Feeling safer) *"Better technology"*
- *"Generally feel that as time progresses and accidents happen, the findings contribute to increasing safety"*
- *"One would expect safety elements to improve with technological advances and the increasingly more vigilant safety culture generally"*

4.2 Use of Data

The survey resulted in this set of data that answers all the questions about discrete elements of perception that go to form an opinion, and subsequently guide decision making. However, in order to predict the aggregate response to a safety risk it has to be recognised that an individual forms their opinion from a complex interaction of these elements. To achieve this state of knowledge, the next chapter deals with a more complex analysis of the survey data.

5 The Aggregate Response to Safety Risks & Accident Costs

5.1 The Work Decision Scenario

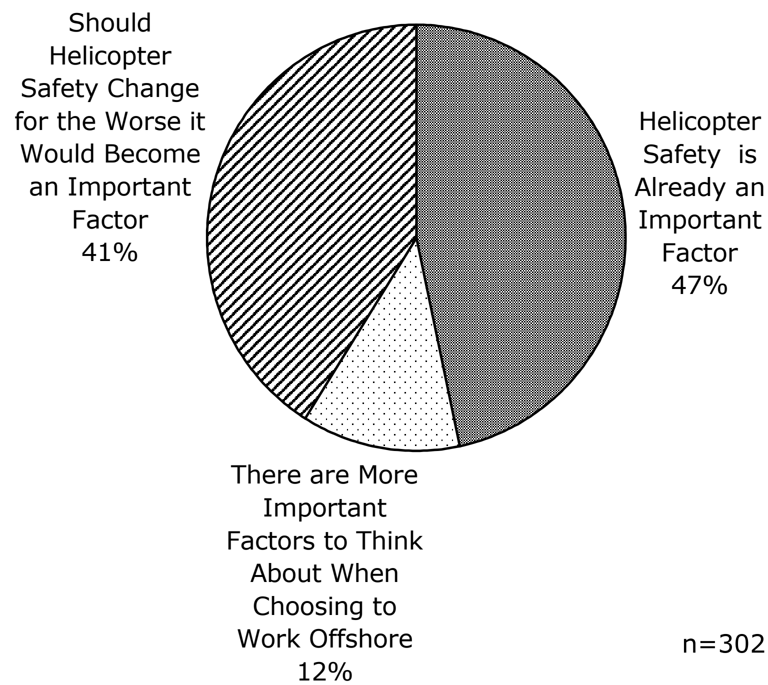
Passengers using offshore helicopter travel will have a demand function that is differentiated from that for other types of passengers: the reason for travel is entirely business, it is essential for employment (in the UK offshore oil industry), and there is no intermodal competition (i.e., it is not possible to elect to travel by boat, for example). This equates to a defined set of decision outcomes for the individual offshore worker:

1. Safety of helicopter travel is perceived as acceptable, and the work decision is based on other factors of employment.
2. Safety is perceived as unacceptable for the given rate of compensation (pay), and the terms of employment need to be renegotiated to incorporate higher factors for the risks of helicopter travel.
3. Safety is perceived as unacceptable, and alternative employment that does not require helicopter travel needs to be sought.

Taking as a framework for analysis Savage's (1998) customers' utility function under conditions of imperfect information, which includes the parameter for 'customers' perceptions of the preventive efforts undertaken' (p.105); it is possible to examine the likely consequences of any perceived shift in helicopter safety from the data supplied in the survey.

In the first instance, respondents were asked to state how important the issue of helicopter safety is as a factor in their own work decision (Fig.32). As it can be seen, 88% of the survey sample state that helicopter safety is either already an important factor or it would become an important factor, should it be perceived that standards have dropped. Although this is an important result, as it demonstrates that the principle of Savage's theory is probably valid, in itself it does not provide enough information to develop the 'parameter of safety perception' into a meaningful or useable function.

Figure 32: Perceived Safety & the Work Decision



As outlined in Chapter 3 and Appendix C, the questions were constructed to determine the range of opinions on a broad range of aspects concerned with the perceptions of helicopter safety. Given any particular question, some responses are more precautionary or risk averse than others. So, even though answers from one respondent will not necessarily be the same as those of another similar respondent on each and every subject, overall they may exhibit a similar cumulative risk response. This is the basis of analysis for the 'work decision scenario'.

Wherever a question in the survey has elements that can be viewed as more or less precautionary, or risk averse, it was assigned points on an ordinal scale accordingly. As expected, the permutations are considerable, and to ease the management of this data the tables of responses were organised according to two sub-categories. The first, those respondents who had stated that some risks were generally unavoidable, and secondly, those who had stated that there were still too many dangers in life (Fig.5). Finally, totals for each set of responses were adjusted according to the response given for how important helicopter safety is in framing decisions about working offshore (Fig.32). Of the 309 returns in the sample, a slightly reduced number of 284 were complete enough to use in this analysis. As stated before, each of the responses to questions were assigned points as a rating of risk aversion; varying according to the directness of any relevance to overall perception of safety, and the clarity of any distinctions between alternative responses. These tables are attached in full at Appendix E, however the system of assigning a risk aversion rating to alternative responses is given below:

QUESTION & ALTERNATIVE RESPONSES	RATING
Q2. With which of the following statements would you most agree?	
I believe risk is unavoidable, but life is generally safe.	0
I believe risk is avoidable, and there are still too many dangers in life.	2
Q4. With which of the following statements would you most agree?	
Safety Regulators should never compromise on safety in their actions.	2
Safety Regulators have to make some allowance for cost in their actions.	1
Safety Regulators have an equal obligation to safeguard the financial viability of the industry.	0
Q6. With which of the following statements would you most agree?	
Self-regulation in safety would be the most efficient system for helicopter operations.	0
A light regulatory touch from the state is the most efficient system for safe helicopter operations.	1
A strong system of state regulation is the most efficient system for safe helicopter operations.	2
Q8. Serious accidents are very rare, but when they do occur there are a number of decisions to be made. With which of the following statements would you most agree?	
All aircraft of that type should be grounded as a matter of standard procedure, at least until more is known.	2

QUESTION & ALTERNATIVE RESPONSES	RATING
The aircraft type doesn't need to be grounded automatically, but Investigation Authorities need to justify not grounding rather than vice-versa	1
The aircraft type does not need to be grounded automatically, and any decision to cease operations is rarely justified.	0
Q9. With reference to individual aircraft operators, with which of the following statements would you most agree?	
The accident record of any company is very relevant to perceptions of safety, and it should be published.	2
The helicopter industry operates to general standards, and so It is only the record of the industry as a whole that matters.	1
Published safety records are open to distortion and misinterpretation, so any publication would be detrimental to overall safety management.	0
Q10. With which of the following statements would you most agree?	
I am only happy to continue flying as long as safety is tightly regulated.	1
Market forces and commercial interest is sufficient to keep flying safe.	0
The media is now more important than government in keeping aircraft operations safe.	0
Q12. With which of the following statements would you most agree?	
The feeling of being safe when flying in helicopters is a major consideration for me deciding whether to work offshore.	4
There are much more important things to think about when choosing where and when to work.	2
Should helicopter safety change for the worse, it would easily become a factor in deciding whether to work offshore.	0

QUESTION & ALTERNATIVE RESPONSES	RATING
Q15. How important is it to be able to express your own opinion about Helicopter Safety matters.	
Very Important.	2
Important.	1
Unimportant.	0
Q17. With which of the following statements would you most agree?	
The safety training is comprehensive and my chances of survival in an offshore accident are high.	0
The safety training is comprehensive, but that the chances of survival are low.	2
The safety training is not comprehensive enough, and the chances of survival are low.	4
Q22. In the event of an accident, how much information are you interested in knowing?	
a. I want to know every detail, so as to make up my own mind about how safe it is to fly again.	2
b. I just want to know the main points, so that I can be assured that the investigation is thorough.	1
c. I just want to know who is to blame	0
d. I don't really want to know any details, as it might stop me flying again.	3
e. Don't know	0
Q25. With which of the following statements would you most agree?	
Every company needs to make a profit, but if a company cannot demonstrate that safety is put above all considerations at every time, it should not be permitted to operate.	2

QUESTION & ALTERNATIVE RESPONSES	RATING
No company can be expected to take an absolute and uncompromising position on safety, and as long as it doesn't have a worse position than anyone else, a company should be allowed to operate.	1
The market forces are sufficient to ensure that safety is maintained at acceptable levels, without any punitive safety enforcement penalties imposed by government.	0

Table 3: The System of Assigning a Risk Aversion Rating to Alternative Responses

What results from this system is a total rating for the likely risk aversion exhibited in an overall perception of safety for a given individual. Although this total rating is represented by a number, it is important to realise that it does not represent any absolute value. It merely gives an indication that a given individual is likely to find a safety risk more or less acceptable than somebody else in the same population presented with the same information. There is presently insufficient evidence to assign any absolute measure to the increments on the scale. Consequently, it is only possible to represent the pattern of respondents that will find an increasing amount of perceived safety risk acceptable or not acceptable, under similar conditions.

It was found that the maximum total rating on this scale of relative risk aversion was 26, and the theoretical minimum is zero. Given that the scale is 26 down to Zero, and as a way to emphasize the relative nature of the scale, it is appropriate to convert the numerical scale (resulting from the sum of the ordinal scores for each response) into an equivalent alphabetic nomenclature (A=26, equivalent to the most risk averse set of responses possible).

The results to the tables at Appendix E are summarised and presented here as the first two columns of Table 4, and illustrated in Fig. 33. The second curve in Fig.33 corresponds to the numbers in the third column of Table 4, and result from a simple moving average calculation, to provide a smoother trend line.

Even though it is theoretically possible for a respondent to provide a set of answers which equal zero according to this formula, it would appear that in reality the limit of any 'risk seeking' (as opposed to 'risk averse') characteristic is a total of 5 (or 'V'). If it is assumed that anything less than that total is an outlier and can be removed from the data, then the resulting curve appears to be a close approximation of the normal distribution. Taking the significant range of values between 'C' and 'T', the mode, median and mean all lie somewhere between 16 and 17 ('J' or 'K'). This is important, because it means that confirmatory data analysis techniques that cannot be used on skewed data, such as confidence intervals, can be used to predict outcomes for the population as a whole.

It is reasonably logical for this curve to be a normal distribution. As discussed at length during earlier chapters, the survey forms part of a study that not only examines the validity of using an assumption that people are generally 'objective and risk-neutral', but also explores the alternative 'behavioural' approach. If the behavioural approach is valid, a normal distribution is a logical result. It merely suggests most peoples' responses will tend towards an average, and (relative to this average) there will be about an equal number of people who are particularly nervous (risk averse), as there are who are relatively incautious (or risk seekers).

From a safety management point of view, it is not necessarily the most important to know how many people are likely to demand changes at any one level of perceived safety risk, rather, the total number of people whose threshold of acceptability has been exceeded by that point. For this reason, the final two columns in Table 4 are cumulative numbers, and these are illustrated in Fig.34.

Table 4: The Number of Respondents Likely to Demand Changes in Response to an Increasing Scale of Perceived Risk.

Perceived Safety Risk	No. of Respondents	Moving Average	Cumulative No. of Respondents	Cumulative No. of Respondents (Moving Average)
A	0	0.5	0	0
B	1	0.7	1	1
C	1	4.3	2	5
D	11	5.7	13	11
E	5	11.7	18	22
F	19	12.3	37	35
G	13	26.3	50	61
H	47	30.7	97	92
I	32	35.7	129	127
J	28	33.0	157	160
K	39	30.7	196	191
L	25	26.3	221	217
M	15	18.3	236	236
N	15	16.0	251	252
O	18	12.3	269	264
P	4	8.3	273	272
Q	3	3.7	276	276
R	4	3.0	280	279
S	2	2.3	282	281
T	1	1.3	283	283
U	1	0.7	284	283
V	0	0.3	284	284
W	0	0	284	284
X	0	0	284	284
Y	0	0	284	284
Z	0	0	284	284
Ø	0	0	284	284

Figure 33: Relative Levels of Acceptable Risk as Stated by Respondents in Survey Sample

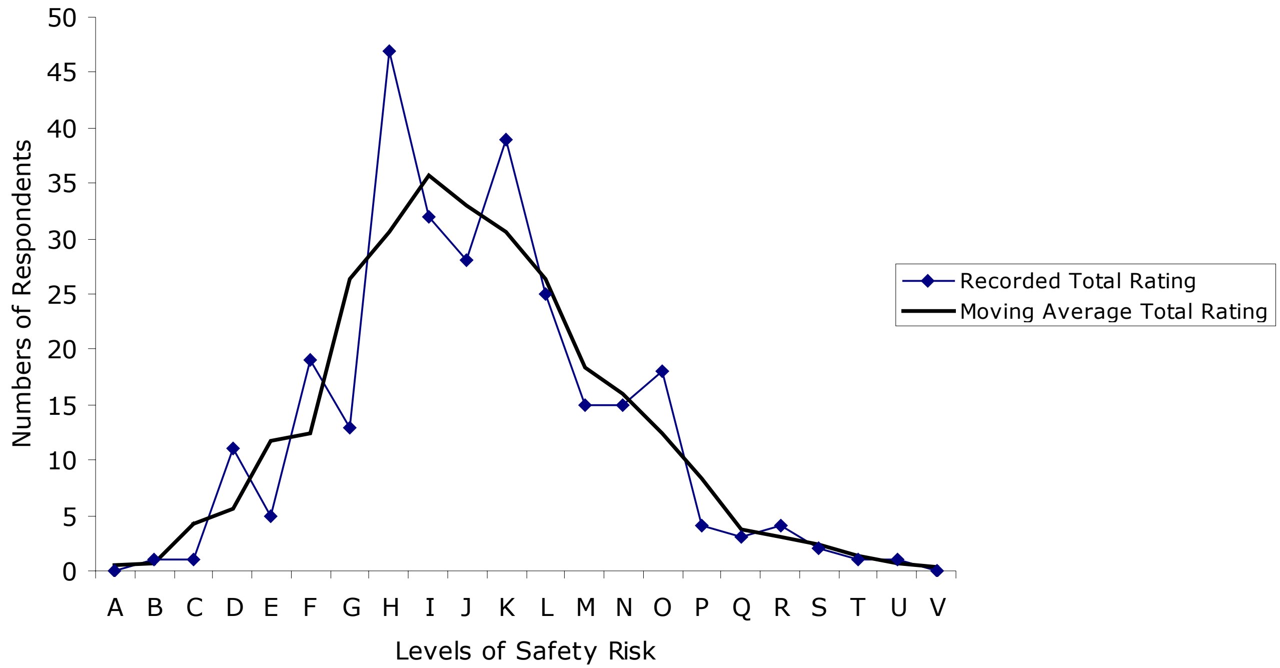
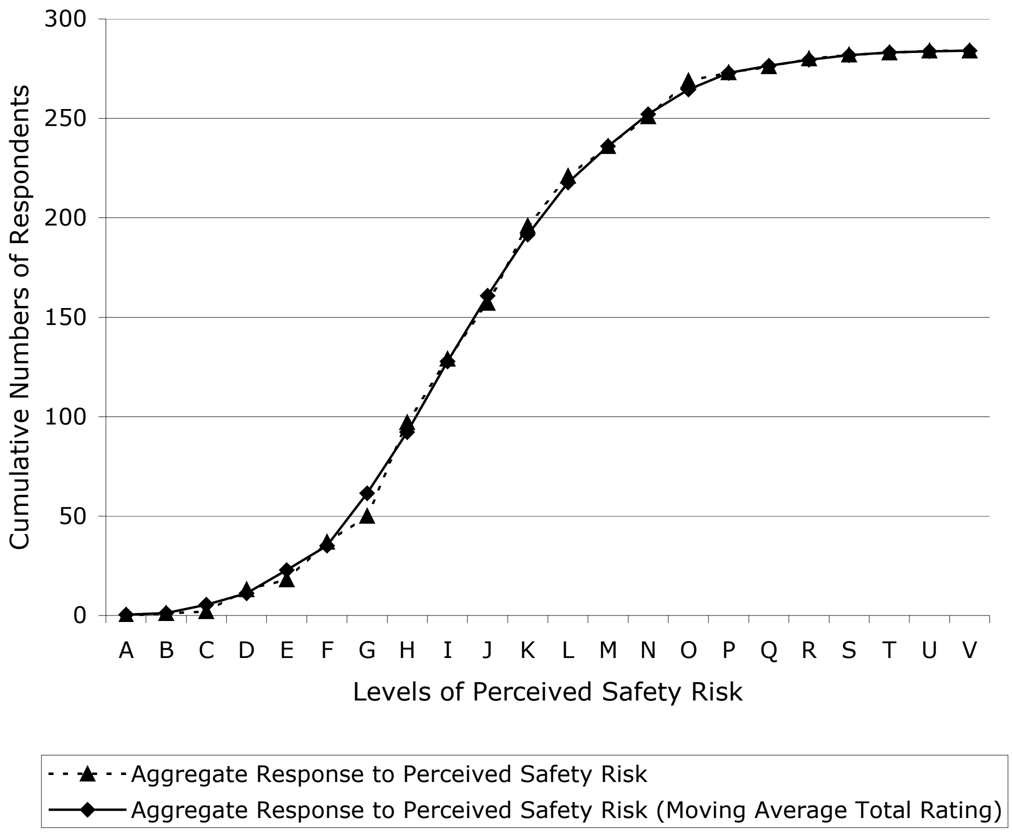


Figure 34: The Cumulative Numbers of Respondents
Affected at Each Level of Perceived Safety Risk



The hypothetical consequences of the information here presented (Fig.34) are that for any perceived increase in safety risk (point 'A' increasing toward 'V'), there will result a corresponding further increment of the population that will adjust their individual demand functions to account for the perceived 'unacceptability' of that risk. Hypothetically, those to the left of this new point on the scale will alter their demand function so that it will require a stronger response (or, set of responses) in order to restore it into the 'acceptable risk' band. In practical terms, this could translate into a shift from 'demands for change' into a 'demand for strike action' and/or 'change of employment'.

In order to forecast the likely numbers of the offshore workforce population that correspond with each increment on this scale of

Perceived Safety Risk, the results from the data in the sample were statistically resampled, using a resampling ratio of 150 (the population is approximately 42,000). Six key points were selected for illustration, and shown here in Table 5.

Table 5: The Proportions of the Offshore Workforce that will Likely Demand Change at Six Key Points on the Perceived Safety Risk Scale.

Proportion	Perceived Safety Risk	Lower Point of 95% Confidence Range (%)	Upper Point of 95% Confidence Range (%)	Lower Point of 95% Confidence Range (No. of Workers)	Upper Point of 95% Confidence Range (No. of Workers)
0.50%	B	0	1.1	0	462
5%	E	2.8	7.4	1,176	3,108
10%	F	6.7	13	2,814	5,460
Lower Quartile	H	10.2	30.3	4,284	12,726
Median	J	44.4	55.6	18,648	23,352
Upper Quartile	L	70.8	81.3	29,736	34,146

Resampling Software: resample.xls (Wood, M., 2003)

It is unlikely that any perceived change from acceptable to unacceptable safety risk can only result in the ultimate outcome of ceasing to travel (strike or change of employment). It is more likely that there is a progressive scale of demands, from a 'demand for technical improvement in the operation', through 'demand for improved pay and conditions (hazard pay)', and then culminating in 'strike action' or 'leave the offshore workforce'. If this model is valid, what expected outcomes do these numbers equate to?

On the basis that during the period of the survey there was no significant or evident demand for change, it is possible to assume that the Perceived Safety Risk was 'A', or less.

According to the model, should the perceived risk rise to 'B', then anything between zero and 462 workers could be expected to seek some evident sign of change. Although it is possible that a particularly risk averse individual might seek alternative employment at this stage it seems unlikely, and it would be more probable that the required response will be a change in some operational or technical matter.

Should the increase in Perceived Safety Risk rise to 'E' on the scale, then these numbers could quickly rise to over 3,000. It is also probable that individuals corresponding to lower trigger points on the scale will demand higher levels of response in order to restore their particular demand function to the 'acceptable safety' band.

For the same shift on the Perceived Safety Risk scale (3 points from 'B' to 'E'), 'E' to 'H' now affects up to 30% of the workforce (or just under 13,000 workers). Then just two more points ('H' to 'J') results in a further 10,000 workers becoming disaffected (45-55% of the workforce in total).

Realistically, if this situation were left unmodified, continued helicopter operations would probably be unsustainable by this point.

5.2 Other Sources of Evidence

So far, it has been possible to conclude that all of the factors reviewed in the survey are linked to mechanisms that frame the overall perceptions of helicopter safety in some way. It is also possible to conclude that it is likely that these mechanisms differ to some extent from individual to individual, and that collectively this produces a significant effect.

If the model proposed in this 'work decision scenario' has any validity, there should be other sources of evidence available to support these conclusions.

5.2.1 The Media and Past Accidents

Taking into account the last twenty years, there have been 6 fatal accidents in the UK offshore oil-support helicopter operations sector:

1. 06/11/1986, a Chinook helicopter (G-BWFC) operated by British International Helicopters suffered catastrophic failure of a spiral bevel gearwheel, killing 45.
2. 25/07/1990, a Sikorsky S61 helicopter (G-BWEL) operated by British International Helicopters collided with a crane above the heli-deck, killing 6.
3. 14/03/1992, an AS332L Super Puma helicopter (G-TIGH) operated by Bristow Helicopters ditched after take-off in bad weather, killing 11.
4. 18/04/1992, a member of the heli-deck crew was struck and fatally injured by the rotor blades of a Sikorsky S76 helicopter (G- BOND), operated by Bond Helicopters
5. 22/09/1995, in an unrelated incident, another member of a heli-deck crew was also killed by being struck by the rotor blades of an SA365N Dauphin helicopter (G-BLEZ), operated by Bond Helicopters.
6. 22/07/2002, a catastrophic failure of one main rotor blade resulted in the loss of a Sikorsky S76 helicopter (G-BJVX), killing 11.

If the conclusions of this section are valid, it would be reasonable to discover historical evidence that some of the proposed expected outcomes actually occur as a consequence of these accidents, and are reported in the media of the time (mainly, printed-press).

5.2.1.1 G-BWFC, Boeing Chinook Helicopter

As is evident from the comments given in the responses to the survey, the impact of this event on many workers' perceptions of safety was so significant that it is specifically referenced some twenty years later.

A keyword-search of the *FACTIVA* database (accessed 09/05/2006), revealed some 28 items of printed-press coverage about the aftermath of this accident. Some of which refer to consequences that are entirely consistent with what would be expected for an event that significantly increases the Perceived Safety Risk (scale 'H' or higher):

- *"The victims were typical North Sea oilmen: hard-working maintenance men and skilled technicians, many in their thirties, and many with young children; some had wives with babies on the way. Their families were used to their absences and some had ceased to worry about the dangers of life on the rigs and hazardous helicopter flights out and back; for others the worry had always been present."* (Foster, H. & McCarthy, M. *The Times*, 8th November 1986)

- *"Boeing and BIH* (British International Helicopters) *are to carry out a trial flight of a Chinook at the weekend as a means of restoring confidence in the craft. However, Shell is still considering whether to resume Chinook flights for workers in the Brent oilfield.. ..Meanwhile, BIH has pointed out that the Chinook's long-range fuel reserves mean that it offers a safety margin not available to other helicopters."* (*The Observer*, 30th November 1986)

- *"Shell has told its workforce that none of them would be required to fly in Chinooks for at least six months to allow a period of reflection. Shell oil workers wrote to their union officials, calling for a permanent ban on the British International Helicopters Boeing Chinook for offshore use.. Since the crash, oil workers have been flown by Shell in chartered fixed wing planes from Aberdeen to the Shetlands and then to the rigs in Puma helicopters."* (*The Guardian,* 27th December 1986)

- *"Shell rig workers continue to boycott the company's fleet of Chinooks."* (*The Observer*, 10th May 1987)
- *"British International Helicopters will not fly Chinooks identical to the one which crashed because the Shell Oil Company is not willing to charter them again until further reports into the accident are known."* (*Textline Multiple Source Collection*, 3rd February 1987)

- *"Although the fault which caused the accident has been identified, Shell, which charters Chinooks from British International Helicopters, is no longer using the Chinook for North Sea flights. The ASTMS* (The Association of Scientific, Technical and Managerial Staffs) *continues to look for further* *safety measures and would like the CAA to change the internal layout of the helicopters, introduce more stringent training for passengers and to look at the suitability of these helicopters for making long flights."* (*Lloyd's List International,* 2nd February 1987)

- *"British International Helicopters is to make 100 people redundant at its Aberdeen base.. ..The company, chaired by Mr Robert Maxwell, attributed these latest redundancies to both a decline in the North Sea oilfields industry and the aftermath of the Boeing Chinook helicopter crash in November."* (*Financial Times*, 28th March 1987)

- "*White collar union ASTMS will outline details today of safety improvements it wants to see in the use of commercial helicopters, following the completion of the inquiry into the Chinook helicopter disaster"* (Freeman, M. *The Engineer,* 9th July 1987)

- *"Privatisation of British Airways could be clouded by a multi-million pound lawsuit arising from the Chinook helicopter disaster earlier this month in which 45 people died. BA's legal department is understood to be on alert for action from millionaire publisher Robert Maxwell, who bought the helicopter from BA three months ago."* (Williams, I. *The Sunday Times*, 23rd November 1986)

- *"North Sea workers have said they are prepared to face dismissal rather than fly again in the Chinook helicopter."* (*The Times*, 18th November 1986)

5.2.1.2 G-BWEL, Sikorsky S61N Helicopter

The *FACTIVA* database (accessed 09/05/2006) gave 16 items of printed-press coverage that related to this accident, which occurred on the Brent Spar platform, 25th July 1990. Again, many of the expected outcomes of the 'work decision scenario' are also evident in the material:

- *"About 60 North Sea oil workers refused to fly out to the oilfields on Sikorsky helicopters until the cause of the crash has been determined. A Shell spokesman said half the men staying in hotels on the Shetland Islands at company expense* *and the rest had returned to Aberdeen, Scotland, by plane."* (*The Associated Press*, 25th July 1990)

- *"North Sea safety has been one of the key factors in reopening the issue of union recognition offshore. These are the union demands and major incidents that have fuelled the debate.. ..July 25, 1990: Six men die when a helicopter crashes close to the Brent Spar."*(*Lloyd's List International*, 13th November 1990)

- *"The threat of a boycott of helicopter flights in the North Sea offshore sector emerged yesterday when British unions raised the issue of compensation for oil workers travelling to and from installations by helicopter.. The unions are demanding guarantees from all North Sea operators, the oil companies and the Department of Energy that the Warsaw Convention will not be used to limit legitimate compensation claims. The TGWU's* (Transport and General Workers' Union) *national secretary for the oil industry, Fred Higgs, said: "If we don't get an undertaking, there could be an averse reaction in terms of the willingness of our members to travel by helicopter.""* (*Lloyd's List International,* 12th October 1990)

- *"Mr Higgs said: "It is absolutely certain that none of our members travelling by helicopter in the hostile environment offshore.. have any idea that any claims for damages resulting from an accident in a helicopter would be limited to £75,000."..Shell said that the issue was a matter for the helicopter operator and its insurers."* (Clement, B. *The Independent*, 12th October 1990)

- *"Meanwhile, the Offshore Industry Liaison Committee, an ad hoc group of oil workers, confirmed a decision to hold a series of strikes later this summer as part of a campaign to secure industrial relations and safety charter. Among the committee's demands are the right to elect a shop steward, and negotiate pay and conditions, as few companies recognise trade unions offshore. Ronnie McDonald, its chairman, said: "The men are required to make between 350 and 370 helicopter trips a year, but we accept it is a fact of life out there. What we are demanding is some sort of input into the way things are administered.""* (Reeves, P. *The Independent*, 27th July 1990)

5.2.1.3 G-TIGH, AS332L Super Puma Helicopter

The following excerpts from printed-press coverage at the time are also taken from the *FACTIVA* database (accessed 09/05/2006). However, there are some particular points of interest in this case; this accident occurred to a fully functioning and serviceable aircraft, and it brought a number of issues concerning the management of helicopter operations to the attention of the offshore workforce:

- *"Oil Company Shell Expro has imposed new safety limits on its North Sea helicopter operations, just weeks before an inquiry into the Cormorant Alpha helicopter disaster in March in which 11 men died… The oil company, which operates the Cormorant Alpha production platform, refused to say whether the accident inquiry scheduled for November 30 had prompted their new policy."* (*Aberdeen Press & Journal*, 14th November 1992)

- *"London – Union leaders are claiming a helicopter which crashed into the North Sea, killing eleven workers, was forced to fly in bad weather because the Cormorant Alpha oil platform was overcrowded… Pending any findings, Shell declined all detailed comment into the cause and circumstances of the crash. But it has moved to fend off pressure over the safety and extent of North Sea flying. Shell Expro managing director Chris Fay said the Super Puma was operating within operational limits, which prohibit flights in winds over 60 knots. It went down in recorded winds of 52 knots. But Shell said 37 oil workers on board Cormorant Alpha – union sources claimed it was more – demanded to be flown ashore amid union criticism of the number of North Sea flights."* (*Platt's Oilgram News,* 18th March 1992)

- *"Cormorant Alpha Helicopter Inquiry Ends With Defence of Aircrew… ,the inquiry heard a spirited defence of the aircrew from solicitor James Roxborough, representing First Officer Hooker's widow. He asserted the flight should never have been allowed to take place. He dismissed repeated assertions North Sea pilots are never put under pressure to fly and claimed that often they were… Campbell, however, criticised Cormorant Alpha OIM* (Offshore Installation Manager) *John Grant for not cancelling helicopter operations despite the fact* *that fast rescue craft could not have been launched in the fierce seas. It was "a remarkable example of the opposite of a safety-first mentality…""* (*The Financial Times,* 27th January 1993)

- *"Evidence of probable job cuts at BP Exploration and worries about Shell Expro's approach to offshore safety has been leaked to the Press and Journal… The document looks at changing contracts of employment, longer trips offshore resulting in fewer helicopter flights, early retirement, job security and changing the ratio of BP and agency personnel… Meanwhile, Shell's alleged problems lie in two areas – helicopter safety briefings and a wave height measuring system operated by the company's Metocean unit. Unit head Ian Leggett, 15 months ago, proposed Metocean's service be extended offshore to help refine Shell's adverse weather policy, which grew out of the Cormorant Alpha helicopter tragedy... The MSF union says measures designed to improve monitoring of weather and sea conditions should be introduced regardless of cost"* (Cresswell, J. *Aberdeen Press & Journal,* 12th February 1993)

- *"Proceedings during the past week in the continuing Cormorant Alpha helicopter inquiry have been marked with contentious clashes between QC's… During questioning of Cormorant Alpha HLO* (Helicopter Landing Officer) *Alexander King last Wednesday, Campbell revealed he had in his possession a written warning issued to victim Thomas Roe, of Rosyth. Dated December 6, 1990, the warning was signed by two senior employees of contractor Press Offshore and said Roe had failed to accept instructions from the Press Offshore HLO prior to boarding a helicopter. King, in earlier evidence, had denied men who raised complaints would be disciplined. But, cross-examined by Campbell, he admitted he had learned of the Roe case – "but not directly". The HLO agreed oilmen used the term "the dead man's seat" for the middle seat in the back row of a helicopter – so-called because there is no adjacent escape window. He also agreed it was the practice to get small men to sit in seats next to the smaller windows in the aircraft. Campbell said Roe had been a small man and had eventually objected to repeatedly being made to sit in a seat which he felt was unsafe… The OIM also told the inquiry he had not known that, prior to that fatal flight, the passengers had been apprehensive. But he knew some* *people feared being disciplined it they refused to board."* (*The Financial Times*, 16th December 1992)

- *"A North Sea oil company was at the centre of a new row over helicopter safety last night as the final submissions were made at the fatal accident inquiry into the Cormorant Alpha disaster. Contract companies working for Elf Enterprise, the operators of the Piper Bravo platform, were accused of docking the wages of 30 oilmen who refused to board a helicopter flight because of adverse weather conditions. The men refused to fly to the Piper platform from the flotel Polyconcorde because the standby vessel could not launch its fast rescue craft in high seas. It was also claimed last night that five elected representatives on the platform's safety committee had resigned after the incident."* (Urquhart, F. *The Scotsman*, 22nd January 1993)

- *"The Civil Aviation Authority will take steps to improve North Sea helicopter safety only after an accident or a near miss, it was revealed yesterday at a fatal accident inquiry… It was suggested … at one point yesterday that the CAA was in the "guard's van" of aircraft safety, rather than in the forefront.."* (*The Scotsman*, 14th January 1993)

- *"Curbs urged on oil rig flights following Shell crash…. "Men out there are frightened and they're saying they're not going back,.."* (Hetherington, P. *The Guardian*, 16th March 1992)

Most of the effects so far highlighted have been the result of a specific accident that highlights some safety issue, either previously unrealised or underestimated (ref. para 2.1.2.2.9, 'Sufficiency Paradox'). However, it is interesting to note a 'Perception of Safety Risk' type reaction is possible in other circumstances as well.

5.2.1.4 Side-Floating Project

Whilst not a direct consequence of any specific accident, the CAA has been overseeing a combined research project to investigate ways that survival from ditching at sea can be improved by preventing the helicopter inverting. The total investment as of January 2006 had been in the order of £250,000 (source CAA, Helicopter Safety Research Committee). At this point it was decided that there were insufficient funds available to take the research any further, and the project was duly suspended.

As the survey was heading towards conclusion, there was a short period of both national and regional press coverage concerning the announcement of this decision to cancel any further development work on the 'side-floating project'. It is interesting to note how this news resulted in outcomes consistent with a small increase in the Perceived Safety Risk.

Although a CAA co-ordinated project, oil companies largely funded it, and yet one of the very last respondents to the survey volunteered the following comment:

"*Because of the stinginess of oil companies & government apathy, the flotation devices are still fitted in the wrong place, allowing aircraft to turn turtle in the slightest seas. These devices should be fitted where the weight is, i.e., engines & gearbox."*

Amongst the printed-press coverage, there have been the following comments:

- *"Oil companies have refused to fund research into a helicopter safety device which could save lives in a crash offshore, the Press and Journal can reveal… Last night Aberdeen North Labour MP Frank Doran protested bitterly over the decision, saying the North Sea remains one of the most dangerous areas in which to work… "There is no question in my mind that the oil industry can afford to pay for this research and their failure to do so raises serious questions about the oil industry's commitment to safety.""* (Perry, D. *Aberdeen Press & Journal*, 6th February 2006)

As indicated by this material from past printed-press, the final key differentiator of an accident occurring in the offshore helicopter environment to any other sector of commercial aviation is that externalities will be concentrated into losses borne by just one or two institutions (the oil companies).

Consistent with these conditions, it would be logical to observe patterns of decision-making in the aftermath of an accident in the offshore helicopter environment that reflects the altered priorities and pressures of the parties involved.

5.3 The Costs of Accidents under Conditions of a Work Decision Scenario

It has been demonstrated, by the sophistication of responses to the perceptions of safety survey in this study, that the average offshore worker has access to higher levels of knowledge about safety matters than other passengers do.

It has also been established that the demand function for the average offshore worker is differentiated from other types of passenger in that there is no intermodal competition, and it manifestly forms a part of the individual's wider work decision.

As stated in the foreword to this study, the tragic loss of a Bristow Helicopters S-76 helicopter and all onboard on the evening of 16th July 2002 appeared to result in many consequences affected by these conditions.

5.3.1 G-BJVX, Sikorsky S-76 A+ Helicopter, 16th July 2002, Leman Field, Southern North Sea

"The crash, on Tuesday, has alarmed workers in the North Sea oil industry who rely on helicopters to lift them from shore to drilling rigs. Last night the accident was being blamed on mechanical failure. Shell UK, which chartered the helicopter, asked for Sikorsky-76s to be suspended from servicing its oil platforms." (Morris, S. & Bowcott, O. *The Guardian*, 18th July 2002)

For the purposes of this study, it is not the causes of the accident itself that are most pertinent, but rather the actions of all the parties involved during its aftermath, and the associated motivators and drivers of those actions.

As a matter of record, the accident was the result of catastrophic failure of a main rotor blade, initiated in the area of undetected damage caused by a lightning strike in a previous incident, and the unanticipated consequences of such lightning damage (Air Accidents Investigation Branch, Aircraft Accident Report 1/2005).

5.3.1.1 The Costs of the Accident to G-BJVX

It has only been possible to construct this analysis due to the extraordinary cooperation of both the UK Air Accident Investigation Branch, in particular Mr Jeremy Barnett (Investigator in Charge), and Shell Aircraft International, in particular Mr Mark Stevens and Mr Cliff Edwards.

With the information provided, it is possible to identify costs according to the Calabresi (1970) framework of accident costs classification: Primary, Secondary, and Tertiary. These items can then be diagrammatically represented to provide an overview of the aftermath of this accident (Fig. 35).

The total known costs of this accident were over £33M, and it is probable that this could rise to over £35M if some of the unknown items were added. This represents a multiplying factor of 17 on the hull value of the aircraft concerned.

The distinction between 'Accident Costs' and 'Accident Reduction Costs' was taken as being a matter of whether a particular cost item was an unavoidable consequence of the accident, or a consequence of decisions made to avoid further costs.

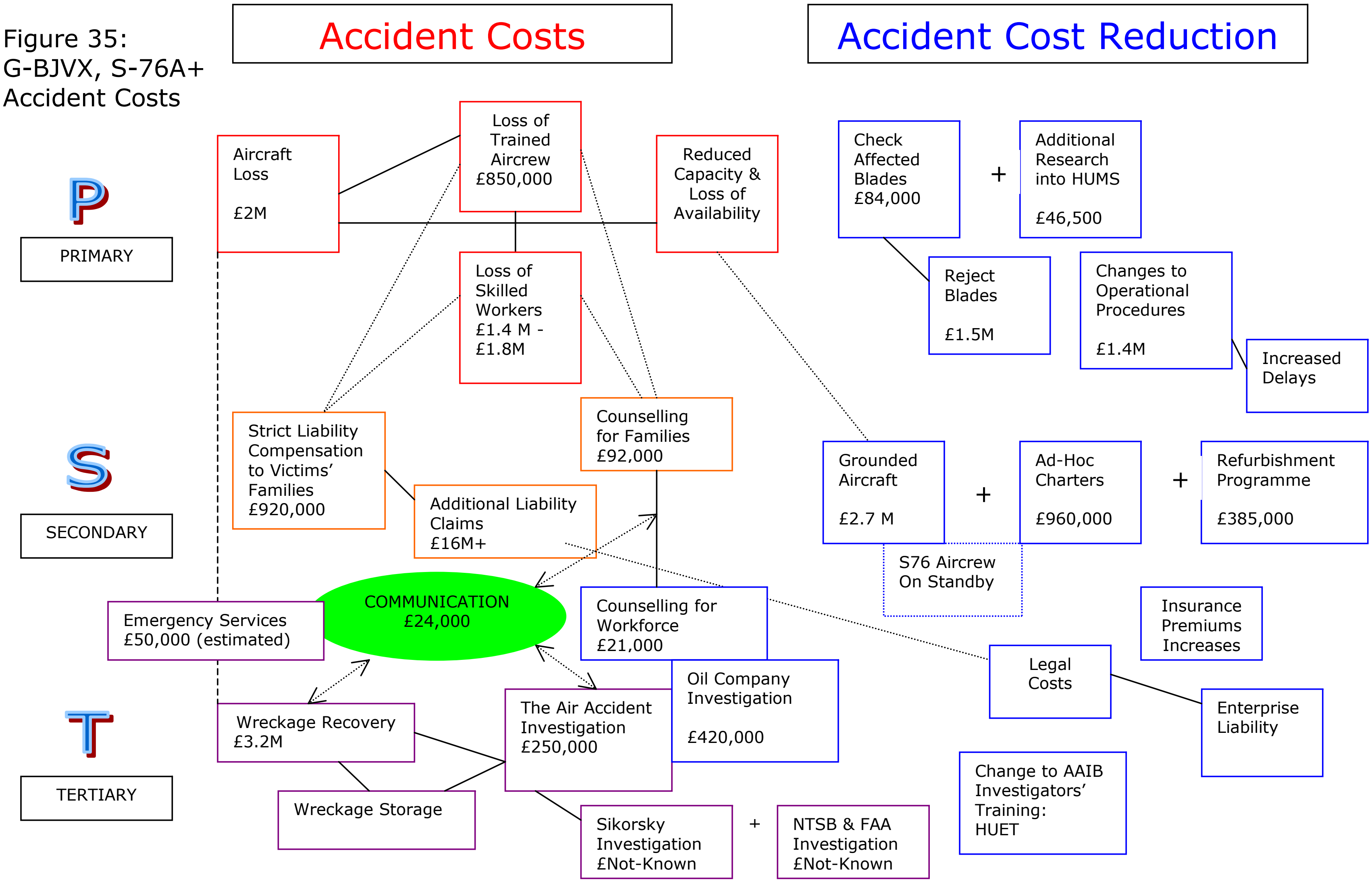
Some of the specific details of how the costs occurred are subject to commercial confidentialities, but all costs represent real outlays and do not include economic losses (except that the estimate of how much the change to operational procedures costs is based on a five year projection at a discount rate of 6% (HSE, 2001)).

The value of trained aircrew personnel is based on the known costs of training, plus the cost of 10 years experience for a Captain and 3 years experience for a First Officer.

The value of skilled offshore worker is based on a similar estimation of training costs, and 3 years work experience.

Neither of these estimates is designed to put a value on life, but it does reflect the real costs of having to replace highly educated and skilled employees in a workforce that does not have access to large surpluses, or can adjust quickly to changes in demand.

Figure 35:
G-BJVX, S-76A+
Accident Costs



The question here is how does this pattern of events and actions differ from that which could be expected in the aftermath of any other aircraft accident?

The most significant decision (from a cost implication) made by Shell was to ground their fleet of S76's far longer than any regulatory requirement. There was a regulatory decision to ground all S76 in the immediate aftermath of this accident, but other oil companies resumed operations within 48hrs or so, once the cause was known to be the failure of a main rotor blade. Shell took the decision to ground their fleet worldwide for 12 days, and the fleet in Norwich for 42 days. This was so the remaining aircraft operating from the Norwich base could be refurbished, to ensure that when operations were resumed the aircraft not only were improved but that they also looked improved. It also gave time for representatives of Shell management to ensure that the aircraft were only re-introduced once the workforce were consulted and convinced it was appropriate.

To cover essential helicopter requirements in the interim, Shell chartered aircraft from other fleets (AS365N2 and AS332L) at ad-hoc rates, whilst still paying the standing charges on the S76 fleet.

This whole programme of actions, designed to maintain the goodwill and co-operation of the Shell workforce, represented discretionary costs of £4 Million.

Shell management, as well as providing the assets to recover the wreckage (£3.2 Million), ran a parallel investigation to the Air Accident Investigation, which represented costs of a further £400,000 + (or nearly twice the cost of the AAIB investigation).

The counselling services for the workforce did not eventually represent a significant cost (£21,000), but that was only because take-up from the workforce was relatively low. If more of the workforce had required it, then it was available.

It is probable that many other cost items, although normal consequences of the accident and subsequent investigation, were significantly enhanced by the special circumstances of the situation.

In all, the discretionary costs borne by the Shell oil company totalled at least £5 Million.

It is not a far fetched assumption that should any worker have decided to leave work as a result of the increase in perceived risk following this accident, even temporarily, then there would be costs incurred in replacing them. If it is assumed that although an experienced replacement could be found and transferred from elsewhere, somewhere in the total system that represents the offshore oil industry a new replacement needs to be recruited. Based on this assumption that there are no readily available surpluses of skilled workers, any replacements represent the full cost of training, pay and supervision whilst gaining sufficient experience in the workplace. For the purposes of analysing the accident costs it was estimated that the cost of replacing any trained and skilled offshore worker can be conservatively averaged to be between £150,000 - £200,000.

Although the decision making by Shell management in this situation was the result of the experience and judgement of managers in the field, and the specialist advisors from Shell Aircraft International, it is possible to estimate the likely cost-benefit of this discretionary spend.

If it is assumed that the 'work decision' model (and the Perceived Safety Risk index) is valid, then the discretionary spend of £5M is equivalent to the cost of between 25 to 33 workers leaving the industry. As it happens, anecdotally (in this case, conversations between one of the pilots who flew the replacement AS365N2 helicopter in the aftermath and workers in the Leman Field) it was rumoured that a small number of workers were actively considering early-retirement or finding alternative employment. There is no documentary evidence that any workers did actually leave the industry as a result of the accident, and so it can be assumed that this discretionary spend to alleviate such consequences (expected outcomes) of the accident were effective.

There were 6 specific references made to this accident by respondents in the survey sample, which represents 2% of the sample.

Given that the accident was probably at an equivalent level of 'E' or above on the Perceived Safety Risk scale, then at least 5% of the workforce might have been adversely affected in some way.

It is unrealistic to assume that the whole offshore workforce would have perceived the increase in risk in the same way, particularly as the S76 is no longer used in the northern North Sea.

For the sake of argument, if it is assumed that just the workers in this part of the southern North Sea were significantly affected, then 5% still represents at least 500 workers.

On this basis, a discretionary spend equivalent to 25 to 33 workers leaving the industry would appear well justified, not just on the basis of well-founded subjective judgement but also on the basis of cost-benefit analysis.

Although the amount of information in the public domain about UK regulatory guidelines makes any comparison of costs difficult to make, the situation in the USA is different. In the absence of any information to the contrary, and for the purposes of comparison, it is assumed that the FAA guidelines would result in similar costs.

5.3.1.2 The Costs of the Accident According to FAA Guidelines

It is interesting to note that the FAA estimate for the cost of an Air Carrier accident investigation is approximately £250,000 – or, the actual cost of the AAIB investigation. However, this FAA guideline is a total cost, and the total investigation cost in this accident exceeds £3.8 million.

The benefit of avoiding 11 fatalities, according to the guide, would be approximately £18 million. This figure is likely to be close to the eventual compensation figure for families and relatives.

However, it remains the case that a cost estimate of this accident on the basis of the FAA guide would still probably only achieve a figure 60 – 65% of the actual costs.

6 Discussion

6.1 Discussion

> *"To be successful, however, any form of transport must achieve a safety record which is good enough to remove from its passengers and potential passengers the burden of fear. This is, of course, a factor which varies widely from individual to individual, but with all of us it is essentially a calculation of risk probabilities."*
> (Wheatcroft, 1964, p.49)

The safety of helicopters remains a significant business threat to both existing operations and for any future growth in the industry, far more so than the maturing fixed wing sectors; this is generally accepted (ref. Chapter 1). But, what is the nature of that threat, and why does it seem so important when, statistically speaking, the reportable accident rate in UK public transport helicopter operations are no more frequent than for UK public transport turboprop aeroplanes (approximately 24 per million flight hours, source CAA)?

The study commenced with the idea that the answers lay in developing the notion that the economics of safety can be resolved into the effects safety issues have on the financial performance of companies, as a consequence of costs of regulatory compliance, or as losses resulting from an unusually high incidence of unscheduled maintenance. If this approach to the study had been successful, it would have suggested that the efficiency of safety management is purely a matter of the technical delivery of engineering standards.

It quickly became apparent during the literature review phase that this approach was unlikely to deliver a better explanation of the economics of safety. Firstly, so many past studies had encountered significant difficulties in establishing reliable evidence of these seemingly intuitive relationships. Secondly, a lengthy phase of secondary research conducted as part of this study, eliminating many of the variables present in previous research (multiple areas of operation, differing types of power plant, different sizes of operation, etc.) and utilising the more numerous data source of Mandatory Occurrence Reports (see Appendix A), still failed to provide anything conclusive.

The question then becomes, is this because the research was looking at the wrong sets of data, or the more fundamental problem of not asking the right questions? What if the accepted problems of integrating cost-benefit analysis into safety management, the identification of efficient regulatory measures, and some of the uncertainties of tort action all originate from an incomplete understanding of the very fundamentals of safety, and thus safety as an economic force? That is to say, there appeared to be a considerable quantity of quality, research based evidence that safety is a complex interaction of human perception and behaviour, but little agreement in the literature as to any exact definition of the word 'safety'. It is difficult to envisage that consistently efficient choices can result from such a situation.

The emphasis of the study then focused on issues of safety management, safety management systems and policy.

As recognised by ICAO, many of the current safety management systems (as adopted by ICAO, the FAA and CAA) need to be modified and adapted if they are to remain relevant to present and future requirements.

Existing guidelines concentrate on avoiding the recurrence of a past accident. Consequently, safety recommendations resulting from accident investigations (or any other sources of safety research) will tend to be assessed on statistical standards (probability), and evaluated in terms of 'injuries avoided' and 'lives saved'. With reference to Calabresi's (1970) comprehensive system of accident costs analysis, such traditional systems help greatly with primary costs, but generally contribute little to assessing safety inputs designed to address secondary and tertiary costs. The evidence gathered during this study supports a view that continuing this policy will not necessarily result in optimal solutions, or efficient economic choices arising from safety problems in the future.

The basis of this finding is that the traditional analysis does not have a reliable, transparent or adaptable method of factoring for the following conditions:

a) The possible variations in definition of safety.

b) The complexity of utility functions, and the possible consequences of a markedly risk-averse population.

c) The extent and nature of any asymmetric information in the market.

d) The nature of agency relationships between government, regulatory authorities and individual members of society.

It is probable that the lack of any real descriptive definition to the word 'safety', at least in the context of aviation, results in an inexact framing of a given safety choice. As Needham (1983) commented, the framing of a regulatory question greatly determines the chosen solution. Therefore, the inexactitudes of definition probably contribute to an incomplete understanding of how perceptions of safety translate into decisions or choices. This likely influences the adoption of the traditional approach to analysis, imposing limitations on the analysis by setting narrow boundaries. This impacts the overall efficiency of safety management systems.

In addition to the problem of definition, the issue of sheer complexity contributes to the difficulty of creating a reliable and valid system of analysis that incorporates such a wide range of variable behavioural characteristics. Empirical studies have developed WTP values for marginal risk avoidance, providing some allowance for risk preference and perception. However, these values are heavily dependent on social and economic conditions, the levels of knowledge about and familiarity with risks, and the state of technology.

Even if the WTP based values and costs are accurate, outcomes to expected utility amongst various segments of the market may still vary. This could result from the tendency of individuals to overestimate low probabilities of loss. As accidents become rarer, to the extent of 10^{-6} (one in a million flights), it is possible to speculate how even relatively minor overestimates could produce significant misalignment of policy and market reaction, based on the principle of expected utility.

The final issue is the one of agency. If the regulatory authorities make decisions based on aggregate data (i.e. the expected disutility arising from a loss to society as a whole), it will likely be very different to one made on the basis of the aggregate response of a population of individuals faced with a similar loss (i.e. the expected disutility arising from the sum of individuals in society).

It becomes theoretically possible to simplify the problem by looking at the outcomes of such analysis, rather than the nature of the utility functions themselves. Then in turn using these empirical results to develop some proxy measure for the 'acceptability of risk'.

The research question then resolved into whether the evidence for such reasoning would emerge through studying a specialised environment, one characterised by the UK Offshore Helicopter Industry.

The data produced by the stakeholder survey (passengers and aircrew) revealed evidence that all the factors supposed to affect the perception of safety are indeed in some form present.

The data also established that individuals exhibit sufficient traits of risk aversion to prejudice the efficiency of ‘traditional’ safety management. It also became clear that the necessary ‘objectivity’ is, to all intents and purposes, absent (only 6 respondents exhibiting any idea of the real statistical chances of a fatal accident).

Establishing that ‘traditional’ safety analysis is likely to fail to produce efficient outcomes, because many behavioural aspects are demonstrably evident, does not fully answer the research question. The real problem remains, proposing an alternative decision-making model that incorporates these behavioural aspects.

The first clue is in the relative importance of the ‘safety record’ of an aircraft to the offshore passengers. When asked the same set of questions (Questions 11, 11a , & 11b; Appendix C) a small set of Air Transport Management MSc students (41 students) gave a markedly different range of responses. 37% of these students considered ‘comfort’ the most important attribute, and only 27% considered ‘safety record’ the most important. In addition, 49% considered the accident record of a particular type of aircraft of ‘no interest’. These students represent a group of knowledgeable aviation professionals, but not necessarily with flight operations responsibilities. This indicates that the opinions of the offshore passengers are much more likely to reflect those of the experts in safety matters.

Although the offshore workforce does not represent a strictly objective population (in an economic, or statistical sense), this result establishes that this group is differentiated from other populations (or groups of passengers) by being more knowledgeable about safety, or safety-aware.

The second clue is the way this more knowledgeable population reacts to perceived increases in safety risk. This population has the ability to interpret new information and the ability to subsequently demand change, demands which can significantly influence decision-making. This was demonstrated by generating the hypothetical 'work decision scenario' and comparing the expected outcomes with evidence from past press-coverage, and the behaviour of responsible authorities in the face of an accident investigation.

So, it has been established that the study represents a well-informed but risk-averse population, that will interpret new information through the filters of well established behavioural factors, and that may subsequently perceive an increase in the safety risk. Should such a situation arise, the scale of the perceived increase in safety risk results in demands for changes, in order to re-establish the risk within an individually determined range of acceptability.

This suggests that rather than economic forces being driven by a fixed 'definition of safety' to any given circumstance, it is more akin to a 'mechanism of safety'. The evidence points toward a stable economic system in which safety is not a significant force until a perceived failure (or new safety information) acts as a disturbance to the system. Safety inputs then have to be made to restore stability to the system.

6.2 The Mechanism of Safety

In order to develop this concept, it is useful to reclassify some 'definitions of safety' (as defined in the literature, e.g., Cobb & Primo, 2003) as 'safety states'. This is because they describe some measures of safety, independent of any individual's perception. These are:

- Absolute Safety
- Relative Safety
- Statistical Safety

Additionally, an alternative safety state not specifically mentioned in the literature, but consistently alluded to throughout the material on role of paternalism in complex systems, is Paternal Safety. The evidence in the survey supports this description of a distinct safety state, and it represents a state whereby safety does not need to be measured, because a trusted institution is managing it.

These 'safety states' will form the base of this proposed model for the 'mechanism of safety' (Fig. 36).

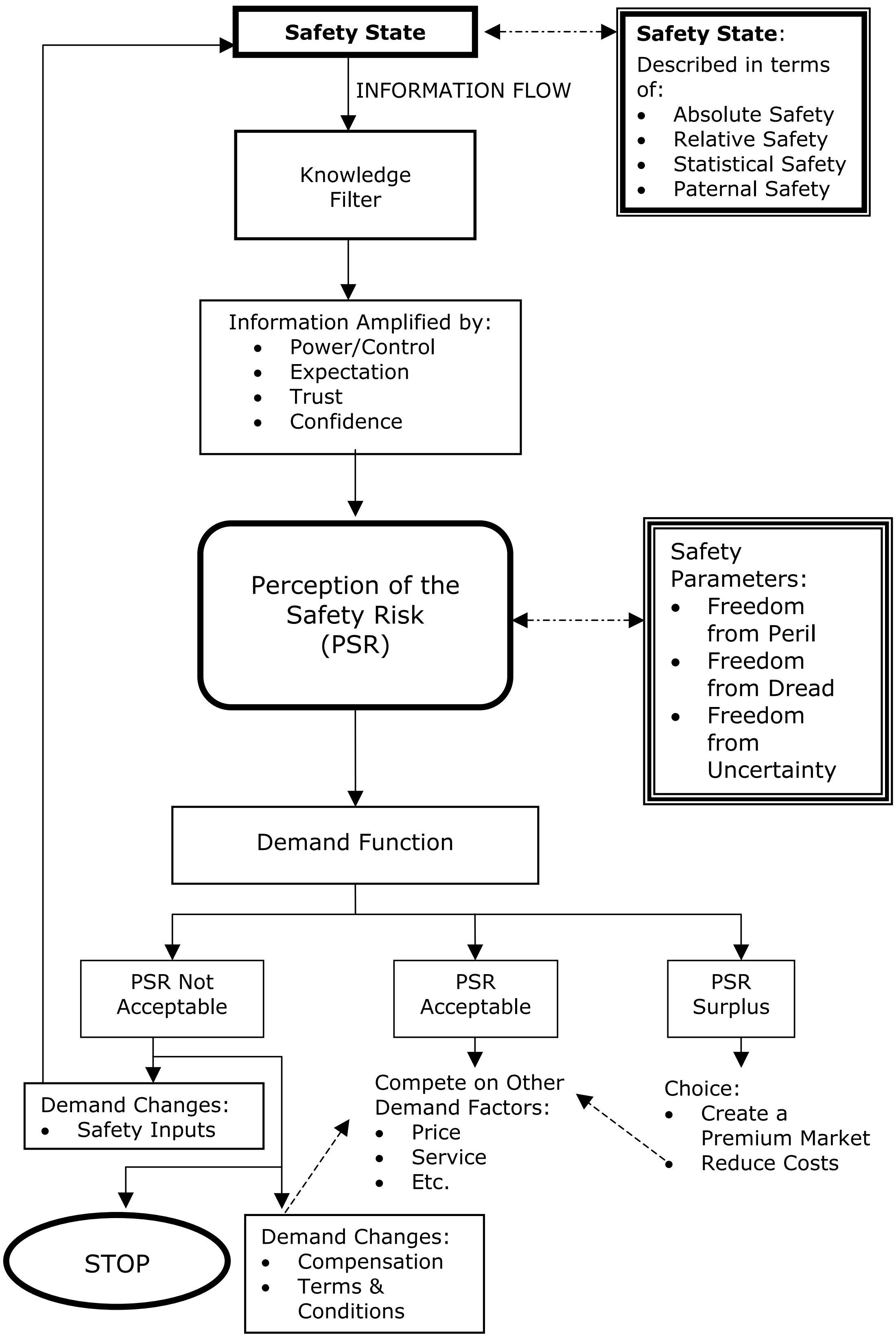


Figure 36: The Mechanism of Safety

It is already known that the ICAO believes that the economics of safety may well be predicated on the perception of safety, rather than any measure of safety. For example, it is written in the Safety Management Manual, 2006: *"The air transportation industry's future viability may well be predicated on its ability to sustain the public's perceived comfort regarding their safety while travelling. The management of safety is therefore a prerequisite for a sustainable aviation business"*(ICAO, Safety Management Manual, 2006, p.1-4).

This is consistent with Savage's theories about the demand function operating within boundaries of 'acceptable safety', and safety only becoming a factor when the perceived risk falls into the unacceptable. The main tenet of the theory, as described by Savage (1998), is that the demand function is controlled by a factor representing the perceived level of safety in any transport operation or activity. The evidence in this study has substantiated the theory, but also points toward a slight variation on the theory. Savage considered the perception of safety as a variable parameter, integral to the demand function. It is more likely that the parameter is a step function, or binary character, that is not necessarily an integral part of the demand function under normal conditions. In order for that demand function to operate, it is a pre-condition that safety is within the bounds of acceptability. Should safety be perceived to drop below the acceptable, according to this version of the theory, the normal operation of the demand function is not modified, it ceases. In order to restore the normal demand function (where competition is decided on the basis of price, comfort, convenience and service) safety inputs need to be seen to be made, sufficient to restore the boundaries of acceptability.

These findings are also entirely consistent with the findings of other researchers investigating the relationships between financial performance and accidents (Barnett, et al., 1979; Dionne, et al., 1997; Golbe, 1986; Mitchell & Maloney, 1989; Oster et al., 1992;Rose, 1990 & 1992; Talley & Bossert, 1990).

Either the pre-condition of acceptable safety is there, and the demand function operates, or it is not, and demand ceases. Stability can then restored by making safety inputs. However, the system is still subject to variability, because of the nature of individuals' characteristics, and risk aversion. The variability of the perceived safety parameter is introduced by the cumulative effect of these differing personal characteristics, rather than via the action of a variable parameter of perceived safety within the demand function, as proposed by Savage (1998). As illustrated through the 'work decision scenario' (Fig.34), a localised accident (provided the primary causes are known quickly) will affect a few individuals significantly, but this is unlikely to represent a sufficient force to shift the market. This is especially the case if the market has a general surplus of demand (most true of airline services). However, with only a slight change in circumstances (e.g., the population becoming aware of a situation previously under a sufficiency paradox, like airport security prior to 9/11) an accident or incident has enough contributing factors to concern a dramatically higher proportion of passengers, and the outcome can tip the market into crisis. In this case study, this finding is supported by the evidence concerning the Boeing Chinook crash in 1986.

Savage also suggested that should the levels of safety exceed the required levels (surplus), as perceived by passengers, then it would be conceivable to create a premium market for those passengers most risk averse, and wanting the extra assurances which such a product might bring. The evidence in this study does not prove that case, but the shape of the Perceived Safety Risk curve (Fig. 34) certainly supports the notion that such a scenario is possible.

The mechanism of safety, as proposed and illustrated in Fig. 36, can be demonstrated as far as the manner in which the Perceived Safety Risk acts as a pre-condition for the system to operate, and as far as the importance of knowledge in becoming aware of a safety risk. However, to complete the model it is first necessary to apply some theory from other disciplines.

The data that emerged from the survey, without too much secondary analysis, established a convincing evidential case that many of the behavioural factors considered by other researchers (Adams, 1995; Cvetkovich, et al. 1999; Douglas, 1985; O'Hara, 2004; Perrow, 1999; Slovic, 2000; Starr, 1969; Tversky & Kahneman, 1986) are of critical importance to the functioning of this mechanism. However, the exact process of how a particular individual translates an awareness of a safety risk, based on a given description of the 'safety state', into a perception of that safety risk, is not immediately available from the data.

To resolve this part of the model, it is useful to borrow the theories of Sen (1999), who has proposed that most pre-conditions of economic well-being and growth can be described in terms of 'freedoms'. It is then a matter of identifying which of these behavioural factors can be described as an internalised 'freedom', and which are more characterised by interaction with the external environment.

To aid this analysis, the following assumption is made: a behavioural factor that can be characterised as an internalised sense of freedom is going to be an output of a situation, whereas one that is characterised by the external environment is going to provide context to that situation.

From the data gathered during this case study, and making particular use of the comments provided by respondents, it is evident that any perception of the safety risk is formulated by:

1. Is there any sense of being in peril? (Freedom from Peril)
2. If there is a sense of being in peril, does the hazard represent something to be feared (does it generate a sense of dread)? (Freedom from Dread)
3. If there is a sense of peril, and the hazard represents something to be dreaded, how certain is the risk? (Freedom from Uncertainty)

The remaining factors of power (control), expectation, trust and confidence will influence the strength of feeling concerning these freedoms, but, in the absence of a situation threatening these freedoms, they cannot generate a perception of safety risk in themselves.

Having completed the structure of the mechanism of safety (Fig. 36), what are the implications for the handling of accident investigations, or safety management in general?

6.3 Reducing Accident Costs

The most convincing framework for accident costs analysis is Calabresi's (1970) structure, categorising costs into three types. Applying that structure to the mechanism of safety proposed here (Fig.36), it becomes possible to identify the points in the process where each type of cost would influence the system. Further to that, it becomes possible to speculate how cost reduction measures would operate to strengthen the system (or re-establish the normal demand function).

Any primary accident costs are principally centred on the 'safety state'. The outcomes of the Perceived Safety Risk are generally secondary costs. The management of the central process is largely attached to tertiary costs.

6.3.1 Safety Inputs, and Cost-Benefit Analysis

The fundamental change proposed in this study is that in addition to cost- benefit analysis being based on the number of lives saved (and injuries avoided), it should incorporate a value for the expected changes in demand. For example, in the 'work decision scenario' illustrated here, a change in the Perceived Safety Risk that results in a demand for a pay increment of 1% would in turn result in a cost to the oil companies in the first year of £21M, and a present value adjusted cost over 5 years (at 6%) of £89M.

When the model proposed in this study is used in conjunction with Calabresi's costs classification, it makes it possible to be very clear and focused about the specific objectives for any proposed safety input to the system. Once these objectives become clear and precise, it is a much more objective proposition to evaluate the expected costs and benefits of the safety inputs.

If the objective is to change the safety state, then this becomes a matter of evaluating the costs of improving reliability (Primary Accident Cost Reduction) and comparing these against the expected outcomes of such a change throughout the process.

Similarly, if the objective is to alleviate passengers concerns about compensation for losses; it is a matter of evaluating the expected numbers of passengers who are likely to change their demand, as a result of finding the Perceived Safety Risk acceptable, for each increment of compensation.

Possibly the most challenging cost-benefit analysis concerns evaluating proposed safety inputs classified as Tertiary measures. Under this system, it should be possible to make these assessments quantifiable as well. If, for example, it is proposed to extend the use of Flight Data Monitoring (FDM) equipment to aid the task of accident investigation, it becomes a matter of evaluating the consequences of not providing the expected levels of certainty following an accident against those for having such certainty, based on shifts in the Perceived Safety Risk.

In summary, the proposed changes to the process of analysis are to have a precise understanding of why it has become unstable (or might become unstable), and then to have clearly matched and targeted strategies to restore an efficient balance to the system.

7 Conclusions

7.1 Conclusions

1. The population exhibits significant tendency towards risk-averse preference, and lacks any realistic understanding concerning probability of accidents. This casts doubt on the efficacy of some of the current safety related regulatory and legislative analytical processes, which have stated guidelines unsuited to these findings.

2. The perception of safety may be based on the measures of safety presented by industry and government, but is defined according to individual tolerances. It is this perception of safety information, interpreted through the filter of knowledge and amplified by cultural factors, that forms the basis of economic stability in the system, and not the measures of the safety state.

3. The perception of safety (or more precisely, the perception of the safety risk) affects the stability of the UK offshore helicopter industry, in the form of an economic pre-condition that the risks are acceptable. Should a sufficient number of individuals in the offshore workforce decide that the risk has become unacceptable (either as a result of new information, or as previously unrealised information becomes available), a number of safety inputs in proportion to the scale of perceived increase in safety risk will be required before a normal, stable demand function is re-established.

4. Cost-benefit analysis based purely on 'lives saved' cannot explain the rational choices of decision makers in the face of a situation where potential economic losses are critical (in this case, the lack of surplus in the offshore workforce and the expected losses from disruptions to production). Cost-benefit analysis augmented by the Perceived Increase in Safety Risk, illustrated in this study, is likely to deliver more socially efficient accident prevention. This is consistent with the evidence of actions and outcomes in the aftermath of an accident under such conditions examined in detail as part of this study.

5. The study has demonstrated that any move by government agencies to modify the system of regulation would necessitate careful evaluation, as a high degree of paternalism, in the form of stringent regulations, remains an important factor in maintaining a stable mechanism of safety.

6. There is much evidence arising out of this study to support the notion that high levels of trust and confidence act as strong stabilising influences on the mechanism of safety (as described here). There is also evidence to suggest that, in the case of UK offshore helicopter operations, the most readily recognised representation of trust in the system is through the conduct of the aircrew. This has many significant consequences for helicopter operators, and the decision-making of operational managers.

7. Safety recommendations are generally made because a shortcoming, or potential shortcoming, has been identified by an expert (Accident Investigator or other industry professional). Decisions about accepting such recommendations would be more efficient if adequate considerations were incorporated for the reaction from passengers, should any subsequent failure actually occur, based on shifts in knowledge and hence the perceived safety risk (i.e. anticipating the potential breakdown of a 'sufficiency paradox').

7.2 Future Research Questions

- This study has established that an acceptable level of Perceived Safety Risk is a pre-condition for the normal operation of the demand function in offshore helicopter operations. It has also been established that it is the cumulative rate at which that pre-condition fails, according to each individual's criteria, that will determine the strength of any subsequent force for change. However, because the number of accidents in the UK offshore helicopter industry is relatively low, it is only possible to guess at the correlation between causal factors and any corresponding level on the Perceived Safety Risk scale (Fig. 34). It would be useful to develop this concept, apply the theory to a wider area of operations, and investigate whether any reliable correlation can be developed.

- This study has studied the particular case of UK offshore helicopter operations and established a mechanism of safety, whereby information about a safety state is interpreted and translated into a perception of safety, and thereby into a decision. It would be useful to explore the validity of this theory as a set of general principles, first to air travel and then to transport as a whole.

- A consequence of this theory is that it is conceivable that a situation can arise whereby a ‘free rider’ strategy could deliver short-term gains. Suppose the levels of acceptable safety have been established as a result of the years flag carriers were able to make (and be seen to make) safety inputs in excess of those required by regulation. It is possible that an operator could decide to reduce the level of safety inputs and receives cost benefits for doing so, without having to compensate passengers for such a reduction (i.e., it still competes on price with other carriers maintaining higher levels of safety inputs), for as long as the situation goes unnoticed by the population at large. However, if this mechanism of safety is generally valid, it is also conceivable that such a strategy introduces a latent failure to the market as a whole. Should a situation arise whereby these cost reductions are exposed as contributory factors to an accident, the aftermath could tip from a relatively localised or short term market impact (for example, the aftermath of the ValuJet accident) to a full market crisis, dependent on maybe just a few additional factors. It would be a useful exercise to generate some scenarios around experts’ opinions (e.g. Delphi technique) of potential shortcomings in the aviation system (e.g., known areas of where present safety management is subject to a sufficiency paradox) and, using the model proposed here, forecast the likely market impacts.

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Glossary

AAIB	Air Accidents Investigation Branch
AOC	Air Operators Certificate
CAA	UK Civil Aviation Authority
CAP	Civil Aviation Publication
CBA	Cost- Benefit Analysis
CFIT	Controlled Flight Into Terrain
CPF	Cost of Preventing a Fatality
BHAB	British Helicopter Advisory Board
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FDM	Flight Data Monitoring
HLO	Helicopter Landing Officer
HOMP	Helicopter Operations Monitoring Programme
HSE	Health & Safety Executive
HUET	Helicopter Underwater Egress Trainer
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IHST	International Helicopter Safety Team
IHUMS	Integrated Health and Usage Monitoring System
JAR	Joint Aviation Requirements
MORS	Mandatory Occurrence Reporting Scheme
MOR	Mandatory Occurrence Report
NTSB	National Transportation Safety Board
NUI	Normally Unmanned Installation
OIG	Office of Inspector General
OIM	Offshore Installation Manager
PSR	Perceived Safety Risk

SMM	Safety Management Manual
SRG	Safety Regulation Group (CAA)
TOR	Tolerability of Risk
VPF	Value for Preventing a Fatality
WTA	Willingness to Accept
WTP	Willingness to Pay

Appendix A

1. Methodology

Although there have been concerns that an apparently intuitive relationship between financial performance and expenditure on safety exists (or could exist in a future, less regulated environment), and that this could result in an increase incidence of fatal accidents; there is as yet little conclusive evidence either way. The Congress of the United States, in its report "Safe Skies for Tomorrow: Aviation Safety in a Competitive Environment" (1988) concedes that the complexity of overseeing the deregulated market exceeded initial expectations, and that programs and systems for tracking and analysing safety data were required. It further recommended that '*new emphasis could be placed on systematic and regular monitoring of financial conditions and management changes at airlines,..'*(p.6).

When considering this issue, there are two possible states, aside from the null case that there is an absence of any relationship. The first is that financial performance can affect the safety record of an individual operator or airline (Rose, 1990), the second is that the safety record can affect the financial performance (Mitchell & Maloney, 1989).

Whichever approach is taken, or possible combinations of these, it has to be acknowledged that there are a number of inherent complexities that make causal relationships particularly difficult to detect, let alone describe in any meaningful context. These include:

1. Accidents, although significant events, are both statistically rare and random.
2. When considering airline operations, there are many other operational circumstances that need to be factored, for example:
    a. Type and size of organisation
    b. Long haul vs. short haul
    c. Type of aircraft
    d. Geographic location and scope of operation
    e. Regulatory, cultural and economic environment
3. The time line of any serious accident and subsequent investigation tends to be lengthy, making discrete observation and correlation of 'cause and effect' particularly problematic.
4. Historically there has been, and to some extent continues to be, a marked lack of symmetry in information, with the market being generally at a distinct disadvantage.

It is often considered that the most significant obstacle to meaningful analysis is the, thankfully, rare and random nature of accident data. To overcome this, some researchers have considered utilising the data collected on the more numerous non-fatal incident events. However, as Barnett & Higgins (1989) point out, and as Dionne et al. (1997) discovered, although more numerous, the data is prone to incompleteness and of 'unsatisfactory' quality.

In an effort to factor some, if not all, of these limitations the study focused attention on the helicopter industry, and in particular the offshore oil sector as a case study. The advantages of this are that:

1. The operators all utilise similar aircraft, fitted to relatively uniform standards.
2. All operations are conducted to Public Transport standards.
3. The nature of operations is common.
4. The standard of regulation is common.
5. The general political and prevailing socio-economic conditions are common.
6. The asymmetry of information is less skewed, with the major oil operators (de facto customers) assuming a very active role in overseeing and monitoring the contracts they place.

The most logical starting point is the relatively low level safety events reported via the various occurrence reporting schemes, which are designed to capture information on all events that have had or may have an impact on the safe operation of aircraft. In the UK this scheme is known as the Mandatory Occurrence Reporting scheme (MOR), and managed by the Civil Aviation Authority. The monthly reports contain summary information on any event that can be classed as either an incident or an accident, where the differentiation is made by severity of consequence rather than circumstance.

Is the present Mandatory Occurrence Reporting Scheme actually a richer source of information than presently realised? The existing MORS has been designed to capture information on all events that have had or may have an impact on the safe operation of aircraft.

MORS published monthly reports formed the main source of data for the study, in which summary information on any event classed as either an incident or an accident is listed on a case by case basis (where any differentiation is made by severity of consequence rather than circumstance), along with details of aircraft type and the reporting organisation.

At the time analysis of the data was being undertaken, the latest report gave the Feb 2004 incidents.

In order to establish industry groupings, the CAA and BHAB (British Helicopter Advisory Board) records were researched to identify the number of aircraft being operated, and the nature of activity undertaken by individual organisations.

2. Rotary Wing Occurrences Submitted by Each Offshore Helicopter Operator Organisation

As stated in the ICAO Safety Management Manual (2006), there are many business situations that are recognized as having an impact on general safety risks. *"6.6.2 Some situations should alert State aviation administrations to the possible need for applying risk management methods, for example:.. a) start-up or rapidly expanding companies; b) corporate mergers;..d) companies facing serious labour-management difficulties;.."*(p.6-11, 6-12)

The reporting behaviour exhibited by the offshore sector of the helicopter industry has produced a sizeable quantity of data. To examine whether a time-series analysis of MOR data could deliver evidence of periods of organisational instability, the UK offshore helicopter operators were examined in detail. To de-identify the organizations concerned, single letter abbreviations are used in the reporting of data.

Over the period 1995 – 2004, there have been 5 companies operating in the offshore role, in the UK sector. However, one operator's entry to the UK sector was short lived (consequently not shown in Fig.1), and on a relatively small scale (4 to 7 airframes compared to 45+ for the incumbents). In addition, Operator 'C' is the result of a merger between 'A' and 'B' in September 1999. So, in reality, it is necessary to compare the consolidated data for 'A' and 'B' prior to the merger, with that for 'C' post merger.

The resulting data are illustrated in Fig.1. The difference in the underlying frequency of reports between the two major operator groups (the groups later known as 'C' and 'D') may indicate a slight difference in reporting procedures. It could also be a reflection of the fact that one fleet is more heavily dependent on medium weight helicopter operations, which have a significantly higher frequency of departures and arrivals.

Since there is this uncertainty, it is the purpose of this study to detect any significant shift in the relative reporting levels for one group year on year, rather than merely comparing the absolute level between the groups at any particular time.

The two clear points of interest around 1997 and 2002 remain for the individual parts (A & B), and for the combined organisation that became Operator ‘C’.

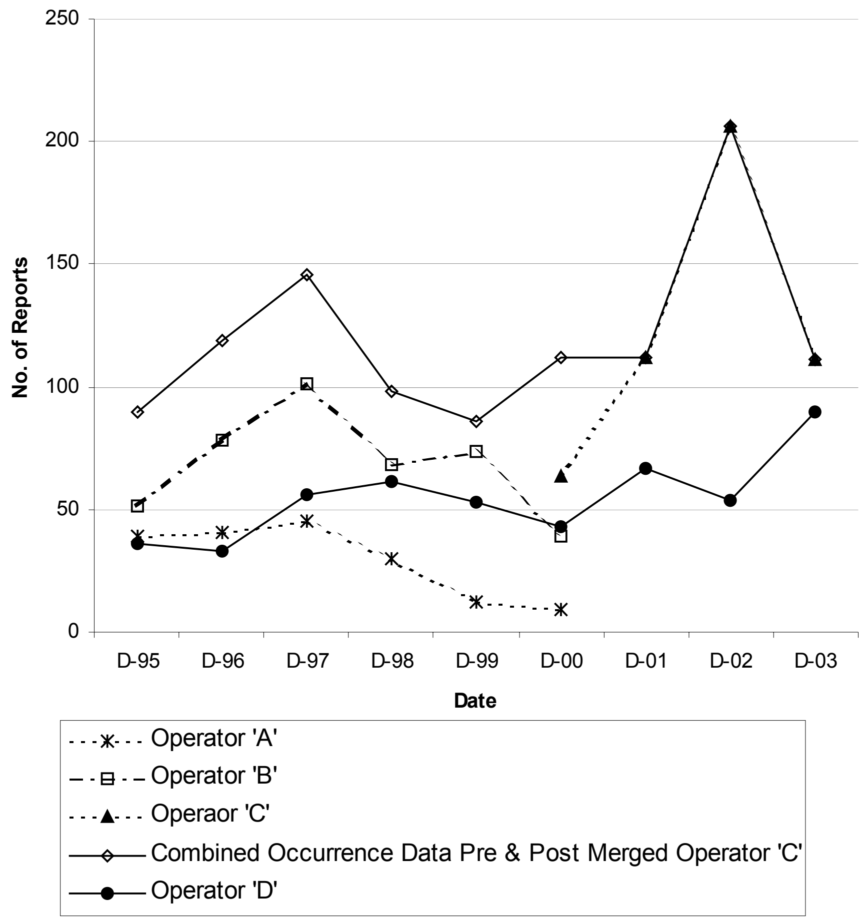


Fig.1 UK Offshore Helicopter Operator Occurrence Reports by Year, 1995 – 2003

These two dates happen to coincide with periods of major change, in these cases, merger and acquisition activity. In 1997 operator 'B' merged with (in reality, was acquired by) another European operator, and in 2002 there followed a further acquisition of this new group by the North American parent company of operator 'A', to form the operator 'C'.

Anecdotal experience suggests a number of potential factors should be considered, for example:

1. Reporting attitudes could change amongst employees as a way to apply pressure on management.
2. The disruption of the workplace during such activity may genuinely affect motivation and has some detrimental effect.
3. Management becomes less cohesive and certain about their goals and responsibilities, arising out of a certain amount of political positioning and confused 'line management'.

What is fairly certain is that something occurs under these circumstances that is reflected in the occurrence reporting data.

Although there is nothing to suggest that absolute levels of safety were compromised by these organisational changes, it is possible to speculate about how a mechanism for elevating the operational risk may occur. In the case of Reason's (1997) model of organisational risk (sometimes referred to as the 'Swiss Cheese' model), it would appear consistent; as the 'holes' become more numerous, longer lasting and possibly larger as well. In the case of Perrow's (1999) description of 'Normal Accidents', it is also consistent; the complexity of the organisation increases with the number of new factors; and the coupling of the organisation becomes tighter, as resources get stretched or less cohesive, diminishing the potential means to divert the course of any developing situation harmlessly.

Whether or not absolute safety standards are compromised, it is apparent that occurrence reporting is affected by such re-structuring and major organisational change.

3. Comparison with Financial Data

These events are of interest because it is generally accepted that most mergers and acquisitions are potentially disruptive, and actually fail to realise the financial benefits intended, often falling below the value of the separate parts. '*..acquisitions and mergers are painful and anxiety producing experiences. They involve job loss, restructured responsibilities, derailed careers, diminished power, and much else that is stressful. No wonder most managers think about how to get them over with – not how to do them better the next time… ..acquisitions that appear to be both financially and strategically sound on paper often turn out to be disappointing for many companies:.' (*Ashkenas, DeMonaco, and Francis, 1998)

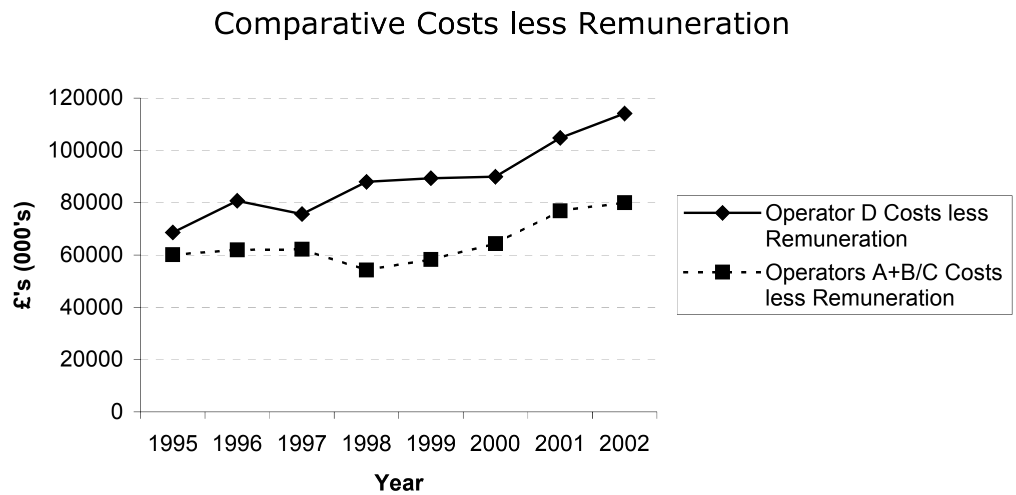
There are some difficulties in trying to compare publicly reported financial data. Namely:

i. Financial Accounting Standards are not absolutely objective, and can be subject to interpretation.
ii. Reporting schedules are not perfectly matched.
iii. Some critical information, namely operating hours, remains confidential.

Figure 1 illustrates two or three points of interest, and in an attempt to analyse these more thoroughly it was important to try and reverse some of the reported Financial Accounts into more readily meaningful Management Accounting type data. For all the financial data, a basic assumption had to be made, but it is problematic and may not be totally valid. In order to get any meaningful comparison on a time line, it is assumed that within any reporting period the financial data can be divided into a monthly proportion, and re-organised into a calendar year without any gross distortion of the information. As Profit, and Operating Profit have been largely discredited as meaningful information, in light of much recent evidence concerning the 'scope' of interpretation available to the accounting profession, it was not the preferred measure for this analysis.

Ideally, it would be useful to get the 'Cost of Sales' figures and then eliminate some of the variables without any direct relationship to safety management. These are principally the cost of fuel and labour costs. It would have been preferable to take the 'cost of sales' less 'employee pay', but as both of these numbers were inconsistently reported, the next best had to be selected, namely 'total expenses' less 'remuneration'. This is illustrated in Fig. 2.

Fig.2:



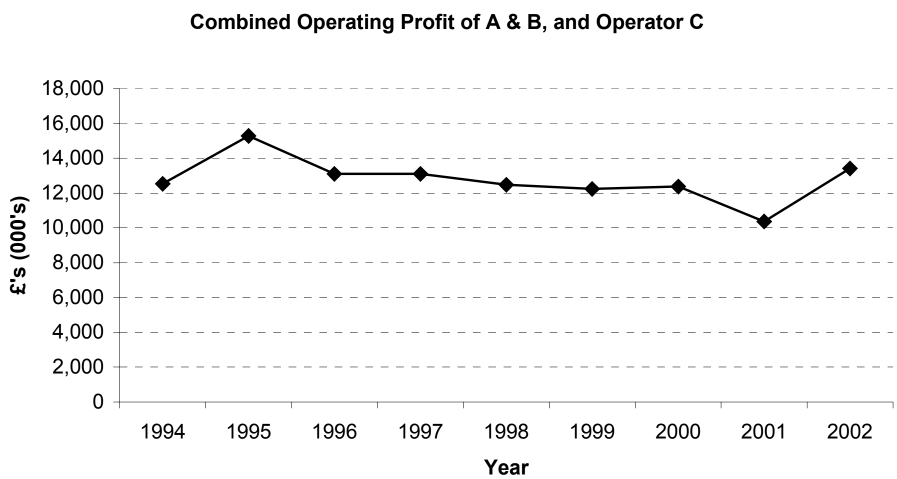
To make any meaningful sense of the data it is necessary to try and get the costs per flying hour or sector. It is evident that the levels of activity will greatly influence both the costs and the likelihood of a 'Reportable Occurrence'.

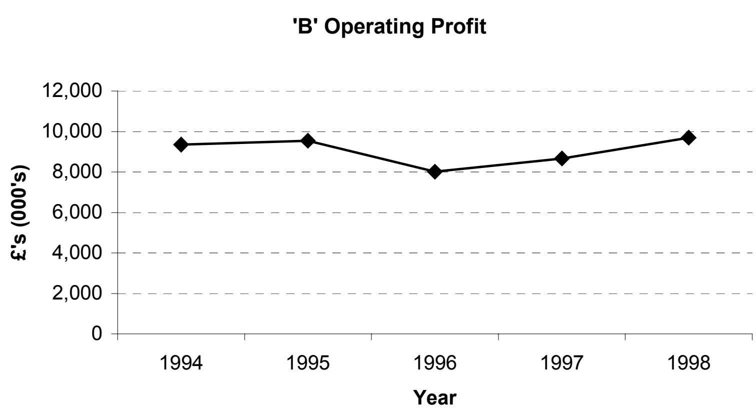
In an attempt to get an approximation of flying hours, CAA data from the 'UK Offshore Helicopter Operations Statistical Report' for years 1995 - 2002 were taken in conjunction with British Helicopter Advisory Board (BHAB) data on the number of aircraft operated by member organisations. Several attempts to find a credible approximation for company specific data were tested, but, to date, no such output has been sufficiently robust to warrant analysis. Problems include:

i. Operator 'D' has a more significant proportion of its operations in overseas areas, which do not necessarily feature in the occurrence reports.
ii. Operator 'A' retained a number of aircraft in the latter parts of the 1990's with a proportionally low rate of utilisation.
iii. The number of aircraft is too inconsistent amongst the various sources of data to be totally reliable.

Taking the information illustrated in Fig 3, it may be possible to consider some correlation between the significant peaks on the number of occurrences occurring for 'B' in 1997, and 'C' (post merger 'A' & 'B') in 2002, with the reporting 'Operating Profit' for the organisation(s). In both cases, the peak in incidents was preceded with a drop in operating profit.

Fig 3: Operating Profits





Care needs to be taken, in that the timing of the two events may well be more closely aligned than that, as the assumptions made in order to smooth out the differences in reporting schedules may have skewed the time line slightly. Also, it is difficult to say with any degree of certainty whether there is likely to have been any lead, lag, or any other relationship between these things, or in fact whether it is just similar effects of a completely different cause.

4. Discussion

"9.1.1 After collecting and recording voluminous safety data through safety investigations and various hazard identification programmes, meaningful conclusions can only be reached through safety analysis. Data reduction to simple statistics serves little useful purpose without evaluation of the practical significance of the statistics in order to defines a problem that can be resolved." (ICAO SMM, 2006, p.9-1)

The evidence presented, analysing the period 1995 – 2003, makes a strong case for the idea that the levels of operational risk vary quite considerably without necessarily resulting in an accident, and can be significantly influenced by periods of organisational change and upheaval, as already suggested by ICAO. This is consistent with other findings on organisational change (Ashkenas et al., 1998; Spekman et al., 2000).

With so many other organisational changes occurring at the same time, there is little conclusive evidence that shifts in any key financial performance indicators are directly linked to the rate of occurrence reports.

This may be the result of the fact that this statistical type measure of safety is not in fact the key determinant of safety as an economic driver. Or, it may be that the theory of a relationship between statistical measures of safety and financial performance is sound, but the methodology lacks sufficient precision to reveal the evidence.

5. Conclusions

- There was a possibility that this method would contribute something to earlier attempts to link the financial performance of an operator and its statistical safety performance. However, this remains inconclusive.

- There is also the possibility that the very inconclusiveness of the data is the result, and that the true economic relationship between safety and economic performance of the air transport industry is founded on different measures (or factors) of safety.

- The research should examine further alternative approaches of study rather than seek to develop this one.

List of Illustrations

Fig.1 UK Offshore Helicopter Operator Occurrence Reports by Year, 1995 – 2003

Fig.2 Comparative Costs less Remuneration

Fig.3 Operating Profits

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Glossary

AOC	Air Operators Certificate
CAA	UK Civil Aviation Authority
BHAB	British Helicopter Advisory Board
FAA	Federal Aviation Administration
FDM	Flight Data Monitoring
HOMP	Helicopter Operations Monitoring Programme
ICAO	International Civil Aviation Organisation
MORS	Mandatory Occurrence Reporting Scheme
MOR	Mandatory Occurrence Report
OIG	Office of Inspector General
SMM	Safety Management Manual
SRG	Safety Regulation Group (CAA)

Appendix B

Preliminary Investigation
- Passenger Interviews

Purpose

To aid questionnaire design, by conducting informal discussions with a sample of typical offshore passengers, as individuals and in groups, in their offshore working environment.

Date

11 – 14th May 2004

Location

Forties Bravo, Fixed Oil Platform, 110nm ENE Aberdeen.

Profile

Session 1: 2 x Engineers (male) with many years experience of offshore work and helicopter travel, including: Sikorsky, Bell, and Eurocopter Types.

Session 2: 1 x Heli-Admin (female), whose duties encompass the administration of passenger and freight manifests, and the supervision of pre-flight safety briefs.

Session 3: 2 x Operation Room Controllers (male), 1 with in excess of 10 years offshore experience, the other with 2.5 years.

Session 4: 1x Offshore Installation Manager (OIM) (male), with ultimate responsibility for all aspects of work and safety on the platform.

Session 5: 1x NUI OIM + 2x Engineers (male) NUI[1] Team, experienced maintenance personnel who fly in helicopters the most regularly, generally at least twice per day, in all weathers.

[1] NUI : Normally Unmanned Installation

Key Points

Session 1:

Ref. No.	Subject	Summary of Discussion	Issues
1.1	Priorities	Both participants expressed the opinion that their main priority when choosing a seat was the size and location of exit.	Peril, Size and Location of Exits
1.2	Hazards	Both participants are familiar with Health and Safety legislation, and expressed the opinion that many of the ergonomic factors of embarking and disembarking helicopters, in particular regard to step heights, would not meet normal work standards.	Paternalism, Slips, Trips and Falls
1.3	Environment	Both participants stated that they became very aware in flight of any draughts or rattles associated with doors or windows.	Peril, Design and Build Quality
1.4	Equipment	Both participants stated that they believed that 4 point harnesses were better than just a lap strap, given the main consideration of body restraint. However, one participant did moderate the preference with a concern for how liable such systems are to impeding an underwater escape.	Crashworthiness and survivability
1.5	Behaviour	Both participants considered that the no.1 objective in the design of a passenger compartment was to make it as relaxing as possible, as both participants were confident in their own and other passengers' abilities to	Peril, Comfort, Dread, Survivability, Human Factors

Ref. No.	Subject	Summary of Discussion	Issues
		conduct drills effectively provided no panic ensued. One participant cited a belief that "In that Sikorsky crash the one guy who survived had been asleep, and so was perfectly relaxed". (*Believed to be a reference to S-61 accident on Brent Spar, 1990)*	
1.6	Drills	Both participants stated that they try to note how jettison handles operate for their exit, but also believe that too much is asked of passengers in an emergency situation, especially in regard to operating life raft systems. If a quiz were to be held after watching the emergency brief, both doubted that the necessary points would be correctly answered.	Survivability, Peril, Design and Operation of Emergency Equipment
1.7	Flight Conditions	The first factor noticed in flight is any change in noise, followed by changes in vibration. Other more minor points include a dislike of flying in and out of cloud, much prefer either in or out.	Environmental Factors
1.8	Pilot Announcements	Both participants felt that the more modern aircraft with tannoy announcements were a retrograde step on the previous headset system, as they are difficult to listen to. Also, they felt it important that Pilots should make efforts to pre-warn passengers about significant changes in conditions, but most importantly keep them informed about the time of travel.	Trust & Confidence, In flight information
1.9	In Flight Entertainment	Both participants could recall a time when some form of entertainment was available to passengers via their headsets, and felt that this was a very positive measure	Comfort, Anxiety, Human Factors

Ref. No.	Subject	Summary of Discussion	Issues
		toward making travel more relaxed, and therefore a contributor to safety by dampening any predisposition to panic.	
1.10	Procedure	Rotors running or rotors stopped disembarkation does not convey any safety consideration whatsoever. Rotors running is by far preferred, as it is perceived as quicker.	Passenger Management
1.11	Performance	Some annoyance was expressed at how baggage weight is managed, with some apocryphal retelling of instances where as little as 5kg has been removed for the purposes of Max Weight. Some doubt was expressed about the accuracy of body weights, and how this makes the situation with baggage contradictory. (*Author's note: Some sectors of the North Sea still use standard weights others actual)*	Regulation, Paternalism, Trust & Confidence, Passenger management
1.12	Maintenance	Both participants stated that they generally formed their view of maintenance based on the visible state of the interior. As engineers, they particularly noticed any fluid leaks. The stated view was, if the trim is "bust" is anything else? They both stated a view that Offshore Helicopters come someway down the list of regulatory requirements, in comparison to other public transport aircraft and even other helicopters.	Regulatory Oversight and Brand Management

Ref. No.	Subject	Summary of Discussion	Issues
1.13	Safety Programmes	Neither participant was aware of the major offshore safety initiatives, in particular the role and significance of IHUMS[2].	Communication, Brand Management
1.14	Training	The whole working environment of offshore operations is predicated on safety management and training, and so the extensive pre-flight briefing used in the helicopter operations, allied with the provision of survival equipment, is taken as normal. The only perceptible impact of such training is not on their attitude towards helicopter travel, but rather on that toward general airline travel. Both subjects felt they take more care to note where they sit, and find the general lack of concern and attention exhibited by other passengers toward safety briefing a source of annoyance.	Passenger Information, survival equipment and unintended consequence
1.15	Questionnaire	Both participants expressed doubts as to how effective any web-based questionnaire would be, as only senior personnel tend to have access to terminals whilst offshore. Both believed that any survey would need to be conducted at the heliport.	Survey Methodology

[2] IHUMS: Integrated Health and Usage Monitoring System

Session 2:

Ref. No.	Subject	Summary of Discussion	Issues
2.1	Statistics	No awareness shown about the state or role of accident statistics.	Perception
2.2	Training	The participant expressed her opinion that because of training, she felt far more confident of her chances of escaping an accident in a helicopter than other aircraft. In fact, she generally felt safer in a helicopter "as our windows come out". However, she did express the opinion that the safety videos have been too long in the past, although better now, and contained too much information to absorb at once.	Passenger information and perception.
2.3	Behaviour	The participant observed that passengers tend to get ready for flight very early and have their favourite seats, and will endeavour to sit in those chosen locations each and every time – herself included. She generally felt that her priorities in this regard were space followed by location of exit (*Author's note: The participant is of small stature, which may make this comment somewhat surprising at first glance*).	Anxiety, Peril, Comfort, Human Factors
2.4	Drills	The participant felt that although the drills require some passenger participation, these were not too complicated.	Emergency procedures and survivability
2.5	Performance	The participant considered that the general awareness and understanding of the significance of baggage weight was poor.	Passenger information and management.

Ref. No.	Subject	Summary of Discussion	Issues
2.6	Maintenance	The participant expressed the opinion that she wouldn't tend to notice much about the exterior presentation of an aircraft, but may well note the state of interior, inferring that if the general upkeep were poor than something may well not be right elsewhere.	Maintenance, Brand Management
2.7	Flight Conditions	The participant stated that she most noticed changes in noise, with some sense of unease and discomfort during take-off, especially offshore, as it involves a "bit of up and down in the hover first".	Peril, Dread, Human Factors
2.8	Safety Initiatives	The participant was aware of many of the programmes, including IHUMS, but only by dint of her role as a Helicopter Administrator.	Brand Management

Session 3:

Ref. No.	Subject	Summary of Discussion	Issues
3.1	Statistics	Both participants were generally unconcerned about statistics, but expressed the opinion that "it is safer in the helo (helicopter) than in a car". The general assumption being that it's a regulated industry, and that if the aircraft has been released for service, it is therefore safe.	Safety Management and statistics
3.2	Training	Both participants felt more confident about their chances of escape from a helicopter accident than other modes of air travel.	Passenger information and survivability
3.3	Culture	Both participants considered helicopter travel safer, on the assumption that helicopters are more "controllable, as they can come to a stop" and that an emergency landing is better on water "because it's softer".	Passenger information and perception
3.4	Environment	One participant expressed a preference for sitting next to a window, the other (a relatively tall person) stated that his first priority when choosing a seat was space.	Peril, Comfort, Human factors
3.5	Maintenance	Both participants considered the state of interior relevant to their overall impression of maintenance and airworthiness. They tend to associate poor trim and any leaks with age, and age with reliability of the aircraft.	Brand management
3.6	Pilot	Both expressed a high level of confidence in the competence of helicopter crews, and considered the sight of aircrew conducting "walk-rounds" on deck a reassuring measure.	Trust & Confidence, Brand management
3.7	In flight conditions	Although neither participant considered the tannoy announcements a problem both would prefer a headset system that incorporated some form of entertainment system,	Comfort, Peril, Dread

Ref. No.	Subject	Summary of Discussion	Issues
		similar to that used in the past. It was considered that such a system would make a significant contribution to making the business of helicopter travel more pleasant and relaxing.	
3.8	In flight conditions	Changes in noise tend to "grab attention" most during helicopter flight, but, in general, if there is any concern it is during take off and landing offshore, because both participants are conscious of the lack of space and turbulence. It was considered a good flight management practice to pre-warn passengers of likely changes in conditions that may give rise to turbulence and the like.	Human factors and passenger management
3.9	Safety Equipment	4 point harnesses give a greater sense of security.	Crashworthiness and survivability
3.10	Environment	When asked as to which aspects of interior design would they wish to improve, both agreed upon bigger windows first, followed by creating "more room".	Cabin design, human factors and survivability
3.11	Training	Both participants felt that they pay much more attention to airline safety briefs as a result of their offshore helicopter training.	Passenger information and unintended consequence

Session 4:

Ref. No.	Subject	Summary of Discussion	Issues
4.1	Reliability	Reliability is taken for granted, on the assumption that it is a function of licensing and regulation.	Safety management and trust
4.2	Priorities	The participant (a tall man) stated that on boarding the aircraft his priority was "how to get out", and he takes into consideration location of exit and the size and type of passengers in adjacent seats. He has a favourite seat, and tends to become more aware of things when he is not able to sit in that location.	Survivability and human factors
4.3	Environment	The participant is conscious of space, and is uncomfortable with the any sense of confinement, but this is a secondary consideration to the priority of a perceived ease of exit.	Cabin design, Dread, Peril, Human factors
4.4	Maintenance	No particular note is made of aspects of aircraft presentation, although it was supposed that some note is made of the overall impression given by the interior, whether it's tatty or old.	Brand management
4.5	Training	As a result of the training and information provided to offshore passengers, the participant firmly believed that his attitude toward general air travel had been altered. He makes some conscious effort to note the name of airline operator, and takes a dimmer view of airline operations. He has even gone as far as considering taking a smoke hood with him.	Passenger information, Brand management and trust
4.6	Management	The participant could not recall a single incident, in his capacity as OIM, when somebody brought a report or complaint concerning the safety of helicopter operations, any concerns raised tend to be restricted to logistical problems (time, weather, capacity and so-on).	Safety management and performance

Ref. No.	Subject	Summary of Discussion	Issues
4.7	Risk	The participant considered the risks associated with helicopter operations, though not insignificant nor small, well catered for within given operational procedures and the Safety Case, and in relation to other potential risks associated with the whole operation of an oil platform, well down in the 3rd quartile of management concern. Any management issues tend to be restricted to day-to-day concerns over logistical matters.	Regulation, trust and safety management
4.8	Development	Given the perception that safety management is in place, the participant would most welcome improvements concentrated on broadening the "operational window" of offshore helicopter operations.	Market development and customer focus
4.9	Management	Having an offshore based aircraft is considered a very mixed asset, and on balance a "net negative" from his perspective (*Author's note: the nature of the contract does tend to create most benefit for other oil company assets within this field)*	Strategic vs. operational management

Session 5:

Ref. No.	Subject	Summary of Discussion	Issues
5.1	Management	The group considered the main priority during a shuttle operation as minimising the speed of turnaround.	Performance measures
5.2	Safety Management	As the operation is regulated, it is taken for granted that safety is a given.	Passenger information, trust, brand and safety management
5.3	Design for Safety	The group considered the enclosed fan, or fenestron, a feature of helicopter design that made a considerable contribution to safety in the offshore environment.	Design, safety management and performance
5.4	Cabin Environment	The subject group are very familiar with two types of helicopter, the AS332 (Puma) and AS365 (Dauphin), and have past experience of others. The design features that they assessed as good were the: • All-round visibility of the Dauphin • The spaciousness of the older designs as opposed to the perceived confinement in a Puma • Build quality, as the gaps and rattles around the doors in a Dauphin tend to unsettle passengers, tending to make them concerned about the security of the locking mechanism.	Engineering quality, design policy, and human factors

Summary Points

Although the participants had a variety of jobs and a wide range of experience in the industry, and some fly more than others, there were some recurring themes during the preliminary survey.

These include:

1. Statistics seem to have little or no impact in framing offshore helicopter passengers' perception of safety.
2. Training has a significant impact on perception, but not in regard to helicopters but rather in changing attitudes toward aviation travel as whole.
3. Many features of flight conditions attract attention, but almost universally it is noise, or precisely changes in noise, that becomes consciously noticed.
4. The state of interior trim and maintenance influences opinion about the state and presentation of the whole airframe.
5. Nearly all the participants of this small survey were confident in their own ability to conduct emergency drills, and in the level of safety afforded by the operation as a whole, but were almost universally concerned about possible panic. The more experienced workers could recall a period when headsets were provided, through which some simple in-flight entertainment could be played, and when the airframes in use provided more sense of space. Both of these measures were suggested as positive contributors toward making the journey more relaxing, and thereby providing a safety benefit to passengers.
6. Despite the many significant improvements in helicopter safety management sponsored by the oil industry, in particular the IHUMS program, there seemed to be little or no awareness of these benefits amongst the participants surveyed.
7. The safety standards provided by the helicopter operators was generally taken as a given, with a high degree of confidence being expressed in the capability of aircrew.
8. The four point harnesses presently being introduced were universally accepted as a safety improvement, and welcomed as such.

Preliminary Survey - Pilot Interview

Occurrence

A chance discussion with two highly experienced pilots (both over 10,000 hours experience) delved into the concept of trust and regulation.

Date

17 Aug 2004

Location

Humberside Airport.

Profile

Seasoned offshore qualified pilots, with current experience on the S76 type.

Summary Points

1. The July 2002 crash was of greater concern to operator crews than appreciated.
2. A body of pilots that felt that the system of safety regulation had failed crews, by putting unfair pressure on them. By not having made any official moves to ground the aircraft, it resulted in individual crews having to make up their own minds about the safety of continued operations, and in a commercial employer-employee relationship that is a heavy burden.
3. The passengers were only convinced to continue flying because they believed that the crews would not put themselves at any undue risk, but this failed to appreciate the commercial pressure in the relationship.
4. The drip-feed nature of subsequent faults in blades reinforced a general feeling of unease, compounded by the certainty of catastrophic consequences (given the type of component failure).

5. One of these seasoned pilots described the situation as being the first time in his aviation career where he felt an expendable resource of the company, not just economically expendable (with regard to job security) but "physically and morally" as well. The operator companies had placed commercial risks above "a safety first" principle.
6. The same pilot considered partly let down by the company, but mostly by the regulatory bodies. He could not understand why the AAIB and CAA had not taken a more precautionary approach in the immediate aftermath of the accident, given the nature of the in-flight break-up. His trust in such organisations had been completely destroyed as a result.

Interesting Points

1. The system of trust is more complicated than just passengers and the aviation industry. There is a more intricate interplay of interest groups, including flight crews and operating companies.
2. The system of regulation has a part to play in ensuring a "duty of care" within the industry.

Appendix C

February 2005

Air Transport Group
Cranfield University
Building 115
Cranfield
Bedfordshire
MK43 0AL

Dear Participant,

We need to know what you think.

<u>Research into "The Economics of Safety":</u>
<u>Phase 3, Stakeholder Survey</u>

The above research project forms an integral part of a wider study being conducted at the Safety and Accident Investigation Centre, a sub-group within the Air Transport Group, Cranfield University.

The overall objective of the study is to better understand how and why safety matters to the aviation industry, from an economic viewpoint.

The Offshore Helicopter sector of the industry has been selected for detailed study, because it represents a particular set of circumstances where the issue of safety and safety management has a much more obvious part in customer relations.

As in any complex industry, it is not just the structure and framework of organisations and institutions that is important; it is also the perception of that framework and the efficiency of those relationships that has real consequence in the longer-term.

Each company and organisation has a part in the bigger picture, driven by your individual interest. It is <u>your</u> opinion, as a member of those institutions, which is being sought.

This survey is a "tick-box" type format, and should take no more than 10-15 mins to complete.

There really isn't a right or wrong answer to any of these issues, it is how people <u>feel</u> about them that matters.

Although you are encouraged to consider the question carefully, please try to avoid spending too long thinking about the answer, as we are really trying to get your <u>first</u> reaction, or "gut-instinct".

Thank you,

Cranfield UNIVERSITY

Offshore Helicopter Operations: Stakeholder Survey

Sex: Male ☐ Female ☐

Age:

<30 ☐

30-45 ☐

>45 ☐

Organisation:

Exploration & Production ☐

Support Services ☐

Government Institutions ☐

Helicopter Operator ☐

Other……………………………..

Do you have management responsibilities with regard to Helicopter Operations? (*Excluding Flying*)

Yes* ☐

No ☐

*Please describe briefly what those are (e.g. Heliadmin, Logistics etc.)

…………………………………………………………………………………………..

How often do you fly in a helicopter to or from offshore installations?

More than once per week ☐

Weekly or fortnightly ☐

Between 6 and 12 times per year ☐

Less than 6 times per year ☐

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Q1.**<u>Rank</u> the following statements in the order <u>you</u> feel appropriate**:

Rank 1 (High) to 4

The Government Institutions have the greatest responsibility for ensuring Helicopter Safety ☐

The Oil Companies have the greatest responsibility for ensuring Helicopter Safety ☐

The Helicopter Operators have the greatest responsibility for ensuring Helicopter Safety ☐

The Unions have the greatest responsibility for ensuring Helicopter Safety ☐

Q2. **With which of the following statements would you most agree?**

Tick One

I believe risk is unavoidable, but life is generally safe. ☐

I believe risk is avoidable, and there are still too many dangers in life. ☐

Q3. **With which of the following statements would you most agree?**

Tick One

*Flying in helicopters is now safer than it has ever been ☐ ☆

No less safe, but no more safe ☐

Less safe ☐

*Q3a. **If you believe helicopters are now more safe, has there ever been a time when you felt less safe?**

Yes ☐ ☆

No ☐ ☆

*Q3b. **Please provide any particular reason for the answer given?**

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

Q4**. With which of the following statements would you most agree?**

Tick One

Safety Regulators should never compromise on safety in their actions. ☐

Safety Regulators have to make some allowance for cost in their actions. ☐

Safety Regulators have an equal obligation to safeguard the financial viability of the industry. ☐

Q5. **With which of the following statements would you most agree?**

Tick One

The Helicopter Industry is best placed to **recognise** the most effective safety measures. ☐

Government Institutions are best placed to **recognise** the most effective safety measures. ☐

The Oil Companies are best placed to **recognise** the most effective safety measures. ☐

Q5a. **With which of the following statements would you most agree?**

Tick One

The Helicopter Industry is best placed to oversee the **implementation** of safety measures. ☐

Government Institutions are best placed to oversee the **implementation** of safety measures. ☐

The Oil Companies are best placed to oversee the **implementation** of safety measures. ☐

Q6. **With which of the following statements would you most agree?**

Tick One

Self-regulation in safety would be the most efficient system for helicopter operations. ☐

A light regulatory touch from the state is the most efficient system for safe helicopter operations. ☐

A strong system of state regulation is the most efficient system for safe helicopter operations. ☐

Q7. **Aviation is like any other industry, as well as the need to be safe it is subject to everyday commercial pressures, and needs to make a profit in order to survive. With which of the following statements would you most agree?**

Tick One

All details of <u>any</u> safety related matters concerning individual companies should be published, so that nothing is hidden. ☐

Some information is of a technical nature and no public interest is served by publishing, provided nominated third party organisations are fully informed. ☐

Aircraft operators are responsible organisations and should not be forced to divulge unnecessary detail about their safety management. ☐

Q8. **Serious accidents are very rare, but when they do occur there are a number of decisions to be made. With which of the following statements would you most agree?**

Tick One

All aircraft of that type should be grounded as a matter of standard procedure, at least until more is known. ☐

The aircraft type doesn't need to be grounded automatically, but Investigation Authorities need to justify not grounding rather than vice-versa ☐

The aircraft type does not need to be grounded automatically, and any decision to cease operations is rarely justified. ☐

Q9. **With reference to individual aircraft operators, with which of the following statements would you most agree?**

Tick One

The accident record of any company is very relevant to perceptions of safety, and it should be published. ☐

The helicopter industry operates to general standards, and so it is only the record of the industry as a whole that matters. ☐

Published safety records are open to distortion and misinterpretation, so any publication would be detrimental to overall safety management. ☐

Q10. **With which of the following statements would you most agree?**

Tick One

I am only happy to continue flying as long as safety is tightly regulated. ☐

Market forces and commercial interest is sufficient to keep flying safe. ☐

The media is now more important than government in keeping aircraft operations safe. ☐

Q11. **Do you take notice of what type of aircraft you fly in?** (*Airline or Offshore Helicopters*)

Tick One

Yes ☐

No ☐

Q11a. **If you were able to choose between aircraft, how would you order the following factors for importance?**

Rank 1 (High) to 9

a. Comfort ☐

b. Noise ☐

c. Spacious cabin ☐

d. Safety record ☐

e. Location of exits ☐

f. Size of exits ☐

g. Speed ☐

h. Standard of interior fittings (maintenance) ☐

i. In-flight information/entertainment ☐

Q11b. **With reference to individual aircraft types, with which of the following statements would you most agree?**

Tick One

The accident record of any particular aircraft type is very important information, and should be generally available to the public at large. ☐

Modern aircraft are all designed and built to a similar standard, and I take no interest in the safety record of the type of aircraft I am travelling in, even if it were generally available. ☐

Q12. **With which of the following statements would you most agree?**

Tick One

The feeling of being safe when flying in helicopters is a major consideration for me deciding whether to work offshore. ☐

There are much more important things to think about when choosing where and when to work. ☐

Should helicopter safety change for the worse, it would easily become a factor in deciding whether to work offshore. ☐

Q13. **With which of the following statements would you most agree?**

Tick One

*Some of the survival equipment makes the flight unnecessarily uncomfortable. ☐

It is so much more important to have survival equipment that I can easily tolerate any slight discomfort. ☐

*__Please Comment__

……………………………………………………………………………………………..

…………………………………………………………………………………………….

Q14. **Offshore helicopter operations are necessarily conducted largely over water; with which of the following statements would you most agree?**

Tick One

It makes <u>no difference</u> to safety ☐

It is <u>more safe</u> than flying over land ☐

It is <u>less safe</u> than flying over land ☐

(*Please take a moment to say why you answered as you have*)

……………………………………………………………………………………………

……………………………………………………………………………………………

Q15. **How important is it to be able to express your own opinion about Helicopter Safety matters.**

Tick One

Very Important. ☐

Important. ☐

Unimportant. ☐

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Q15a. **In relation to Q15, who is it most important to be able to express your opinion to?**

Rank 1 (High) to 4

a. The Government, through its institutions (HSE/CAA/AAIB etc) ☐

b. The Oil Companies ☐

c. The Unions ☐

d. The Operating Companies (CHC/Bristow/Bond etc) ☐

Q16. **With which of the following statements would you most agree?**

Tick One

The standards of safety in offshore helicopter operations are better than in airline travel. ☐

The standards are neither any worse nor any better. ☐

The safety standards in offshore helicopter operations are not as high as airline travel. ☐

Q17. **With which of the following statements would you most agree?**

Tick One

The safety training is comprehensive and my chances of survival in an offshore accident are high. ☐

The safety training is comprehensive, but that the chances of survival are low. ☐

The safety training is not comprehensive enough, and the chances of survival are low. ☐

Q18. **In any <u>ten year</u> period, how many fatal accidents do you think occur in offshore helicopter operations worldwide?**

……………………………………………………………………………………………

Q18a. **Of those accidents, what percentage do you think are in the North Sea?**

……………………………………………………………………………………………

Note: CAA – Civil Aviation Authority
AAIB – Air Accident Investigation Board
HSE – Health and Safety Executive

Q19. **If you were asked to guess, how would you order the following areas around the World as to the relative toughness in safety regulations for offshore helicopters?**

Rank 1 (High) to 5

a. USA ☐

b. Canada ☐

c. Norway ☐

d. UK ☐

e. Australia ☐

Q20. **How relevant do you believe the standards of safety regulation are to your everyday travel?**

Tick One

a. Very relevant ☐

b. Some relevance ☐

c. Little practical effect ☐

d. Solely a paperwork exercise ☐

Q21. **Whom do you credit most for driving safety innovation and improvement in offshore helicopter operations?**

Rank 1 (High) to 4

a. The Government, through its institutions (HSE/CAA/AAIB etc) ☐

b. The Oil Companies ☐

c. The Unions ☐

d. The Operating Companies (CHC/Bristow/Bond etc) ☐

Note: CAA – Civil Aviation Authority
AAIB – Air Accident Investigation Board
HSE – Health and Safety Executive

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Q22. **In the event of an accident, how much information are <u>you</u> interested in knowing?**

Tick One

a. I want to know <u>every</u> detail, so as to make up my own mind about how safe it is to fly again. ☐

b. I just want to know the <u>main points</u>, so that I can be assured that the investigation is thorough. ☐

c. I just want to know <u>who</u> is to blame ☐

d. I don't really want to know any details, as it might stop me flying again. ☐

e. Don't know ☐

Q23. **Accidents are very rare, but should one happen, whom would you most trust for accurate information concerning the circumstances of the accident?**

Rank 1 (High) to 4

a. The Government Accident Investigators ☐

b. The Oil Companies ☐

c. The Helicopter Operators ☐

d. The Media ☐

Q24. **Accidents are very rare, but should one happen, whom would you most trust for accurate information concerning whether it is safe to fly again?**

Rank 1 (High) to 4

a. The Government Accident Investigators ☐

b. The Oil Companies ☐

c. The Helicopter Operators ☐

d. The Media ☐

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Q25. **With which of the following statements would you most agree?**

	Tick One
Every company needs to make a profit, but if a company cannot demonstrate that safety is put above all considerations at <u>every</u> time, it should not be permitted to operate.	☐
No company can be expected to take an <u>absolute</u> and uncompromising position on safety, and as long as it doesn't have a worse position than anyone else, a company should be allowed to operate.	☐
The market forces are <u>sufficient</u> to ensure that safety is maintained at acceptable levels, without any punitive safety enforcement penalties imposed by government.	☐

Thank you for your time and participation, your opinion matters and will be heard.

<u>How to Return</u>:

A. If you have completed this form in the passenger terminal, please place it in one of the boxes provided.

B. If you have you have been given this form via a nominated company representative, please return it to that individual.

C. Any return may be sent directly to:

Simon Mitchell
Air Transport Group
Cranfield University
Building 115
Cranfield
Bedfordshire
MK43 0AL

Please feel free to find out more about the University and the Department by visiting:

http://www.cranfield.ac.uk/soe/airtransport/csaic.htm

Questionnaire Analysis

The questionnaire resulted in 32 elements, from which data could be collected and organised to provide evidence for conclusions regarding the stated research objectives.

As a way to check that all potential factors were adequately covered by the final draft of the questionnaire, the potential output for each question was analysed for elements and sub-elements of theory covered in the literature review. The resulting information is presented in Tables 1a & 1b.

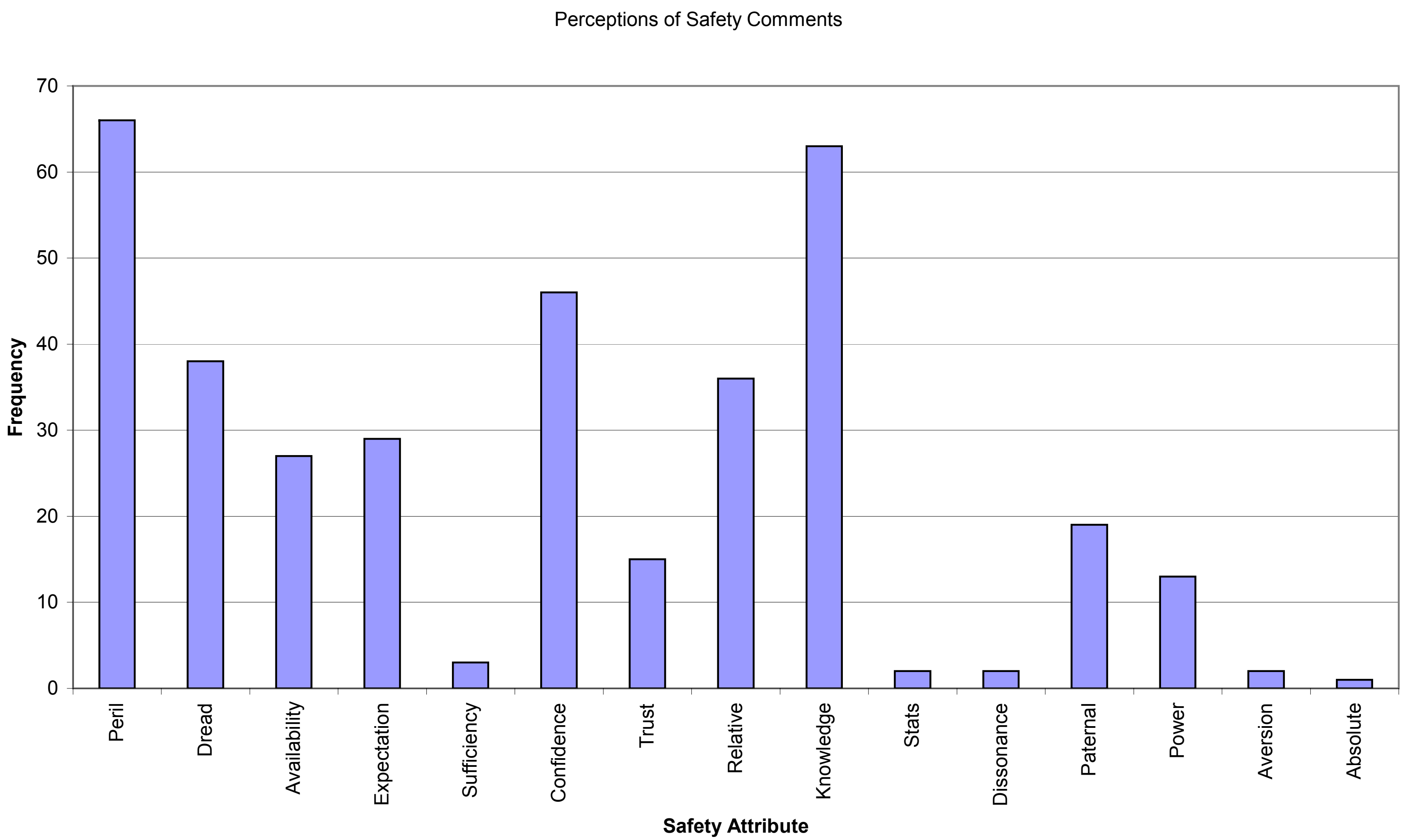
Q	1	2	3	3a	3b	4	5	5a	6	7	8	9	10	11	11a	11b
Absolute Safety						1										
Relative Safety		1	1									1				
Statistical Safety																
Paternalism	1					1	1	1	1		1	1	1			
Uncertainty										1	1	1			1	
Peril				1	1					1	1			1	1	
Dread				1	1											
Availability			1	1	1										1	
Knowledge										1				1	1	1
Power / Control																
Expectation	1					1										1
Trust	1								1						1	
Confidence	1						1	1					1		1	
Aversion		1				1					1					
Totals	4	1	2	3	3	4	2	2	2	3	4	3	2	2	6	2

Table 1a (Appendix C) : Question Plan

12	13	14	15	15a	16	17	18	18a	19	20	21	22	23	24	25	Totals	Q
															1	2	Absolute Safety
		1			1				1							6	Relative Safety
							1	1								2	Statistical Safety
				1	1				1	1	1		1	1		15	Paternalism
												1	1	1		7	Uncertainty
1	1	1			1	1										11	Peril
	1	1														4	Dread
																4	Availability
		1			1	1			1							8	Knowledge
1			1							1						3	Power / Control
					1				1						1	6	Expectation
									1	1	1		1	1		8	Trust
										1			1	1		8	Confidence
1															1	5	Aversion
3	2	4	1	1	5	2	1	1	5	4	2	1	4	4	3	89	Totals

Table 1b (Appendix C) : Question Plan

Appendix D


Perceptions of Safety Comments
Frequency
0
10
20
30
40
50
60
70
Peril
Dread
Availability
Expectation
Sufficiency
Confidence
Trust
Relative
Knowledge
Stats
Dissonance
Paternal
Power
Aversion
Absolute
Safety Attribute

Ref No	Q3b	Q13	Q14
1			Risk of capsize, esp in bad weather, remoteness of rescue
2			Most helicopters can land I believe survival would be easier on land
4	Everything nowadays is aimed at safety so they should be safer now than they have ever been realistically		Weather conditions in water aren't very good, sometimes in N Sea at best of times you can mostly land all right on dry land if there is a problem
6		Irregularly fitting seals (neck & wrist)	Capsize risk, ability to escape
7		Since 1988 the survival and safety training has improved greatly	A high speed impact is same on land as water
8		The few accidents with helicopters have proven the use of survival equipment	I assume crashing on land is as bad as ditching in the sea
9	Over the years improvements made ie. 2 pilots, improved flying suits, improved lifejackets	Flying suits in very hot weather	
10	I have full faith in pilots		
11	In the 1980s, I was aware of a number of crashes involving offshore travel, now they are almost unheard of in the North Sea		Chances of survival in a water crash virtually zero, but not much better over land. In a ditch better over land
12	Flying offshore/onshore during the late 1980s & early 1990s pressure on companies to fly in very poor weather was present. I flew from NE Shetlands in some awful weather & once refused a flight.	The companies must continue to develop new and innovative ideas for this market	Landing in an emergency on land is much easier than ditching to water at freezing temp.
13	We still operate old technology equipment	Money should be invested in new aircraft not more safety equipment	No terrain clearance issues and generally less traffic
14	Have always been glad to fly in choppers with two engines. Regulation has ensured that risks have reduced.	How many times in the last 30yrs have survival suits been used in earnest & saved lives	No or fewer vertical hazards
15	Following Shell's S76 crash off Leman in 2002. The industry continues to learn from accidents and investigations which continuously improves safety.		
16	I once flew in the Gulf of Mexico in a Huey. That was less safe.		
17	After crashes etc.		If the helicopter has a problem it could be over land or sea
18	I was onboard the Santefe Monarch in 2002 when the S76 went down so for a while I thought about safety much more.		
19			A drop from the air is a drop from the air

Ref No	Q3b	Q13	Q14
22			Whilst water may make for a more soft landing, operations are not affected
26	Flying to NUI from a platform when the wind is calm.	In these waters I feel some of the equipment are unnecessary	Crashing on water is as equal to land
27		Feel that re-breathers are a waste of time	
28		Short flights so safety is more important	Impact of incident over either has major consequences
31			Due to the structure of the helicopter
34			You don't need to swim on land (dumb question)
35			If you are going to crash you will
38	Helicopter crash, S76, no real reason found why	Shoulder harnesses and high back seats are a positive improvement in safety, although slightly more onerous to wear.	A helicopter does not know where it is flying in relation to land or water. Chances of survival in either case are probably equal.
39			The same measures should be taken to ensure safety, whether over land or water (the highest measures)
40	Generally feel that as time progresses & accidents happen, the findings contribute to increasing safety	Whilst recognising its importance, ergonomics must be considered to promote its use	If you survive the impact, survival on land is easier
42		Some items are OTT (re-breathers)	Water or land helicopters should not crash
43	Less incidents now due to awareness		
45	Cost cutting pressure from oil companies (contracts awarded on price)	Passengers wear too much clothing/survival suits in summer	survival less likely after emergency landing
47	When flying single-engined helicopters over water or when single pilot IFR at night in twin-engined helicopters		In flight emergencies can happen at the same rate over water as over land. Properly equipped, a heli can land anywhere on the water, not always possible over land.
48	More regulation and standardisation	Survival equipment designers should be very mindful of sortie length	Safety and survival equipment is provided to suit the operational environment
52	Beginning of the 1980s - safety management/design not what it is now	Qualified answer - depends on duration of flight	In the event of a problem requiring immediate landing you will be better placed on land than water
53	Better diagnostics, engine management diagnostics		Crashes are generally non-survivable whether over land or sea. Controlled ditching in the sea is less safe due to likely sea states

Ref No	Q3b	Q13	Q14
54	In the 80s pre - HUMS/HOMP etc.		
56	Better FDM systems now & diagnostics		Injured passengers may not escape from a/c before drowning. Although impact may be greater on land, injured should survive
58			Wont make much of a difference in case of an emergency
66	Cannot identify anything which has improved safety. Helicopters are 20+ years old!	Neck seals are tight, liners are hot	Helicopters can land anywhere, but are top heavy so flip in water
68	New technology makes it safer now than previously		With engine situated above pax, upon impact (either land or water) it will drop on top of them regardless
69	After landing onshore, aircraft jammed one undercarriage wheel in drain cover on apron. Pilot attempted to use lift from rotor to free the jammed wheel without disembarking passengers first. Aircraft tilted heavily to one	willing to use any item which increases survivability	
70	Ex military. No doors on Pumas in them days		Hitting water at speed just the same as hitting land. Prefer land if controlled landing as you can walk away from the aircraft - easier than swimming
72			You don't have the same opportunity to walk/crawl away from a crash over water as on land!
73			Unplanned landings can be controlled or uncontrolled. Uncontrolled landings are unlikely to be survivable either way. Controlled landings are likely to be safer on land.
74	Comfort in helicopters makes you feel safer and all safety improvements ie. Three point harness make you more uncomfortable.	For a man over six ft two wearing all the equipment I don't be;ieve he could escape, and no way could he assume the crash position. (all helicopters need 3" more leg room)	I believe if I crash I would be very lucky to escape, but, if I survived, to then have to escape in water and wait on rescue - I don't think I have a chance. The chances of the aircraft floating upright, I also believe to be slim.
75			Water temp, ease of rescue, disorientation & panic
76			Search & Rescue, and weather limitations for rescue
78			The important part is keeping the aircraft in the air!!
79		You can have so much "safety eqp" round your neck it is impossible to move. So puts down your chances of getting out of a crashed helicopter.	Does not matter what you are flying over - it is normally the drop that kills you.
81		A lifejacket with integrated air pocket may be more comfortable.	Less likely to endanger lives below.
82	Shuttling from platform to platfoem during adverse weather conditions		Can't say whether flying over land or water makes a difference to safety, apart from the obvious.

Ref No	Q3b	Q13	Q14
83			safety should be standard
85			It may seem less hazardous to ditch in water but it presents its own hazards
87	In the 4 years I have been going offshore little changes have occurred & general culture is to continually improve standards.		both situations have risks & equally important in safety terms
88			autorotation over land is safer, helicopters overturn on water
89			increased recovery time if ditching
90		I am concerned, however, that some survival equipment (airpocket) may hinder my exit in an emergency	Survivability of a forced landing is the same whether on land or water - what matters is your chances once you have escaped the wreckage.
91			It is safer to put down in water
93			Less force of impact if land in water
95			Equal risks/different hazards. Water: drowning/rapid escape req'd - Land:Impact buildings etc/fire
97			If you crash it's not good land or sea
99			Because of the dangers of survival at sea (assuming you survived the crash)
102			In an emergency - unless the pilots have control of the helicopter it does not matter. If it falls from 1500ft, you are lucky to survive.
103	In the early days passengers were not weighed, freight offshore was guessed & put on the flight.		From the point of being rescued, it is less safe flying over water
104		Re-breathers getting in the way when putting seat belt on	
105	Very little safety equipment. Personal, lap life jacket only	Safety equipment has much improved over the years - very basic 25 yrs ago	You can't land in heavy seas
107	Control on overly large/obese passengers		
108	Flying in Gulf of Mexico, not as much preparation training	Flights are not that long	

Ref No	Q3b	Q13	Q14
109	Whilst I believe that safety has increased, in terms of awareness of risks associated with helicopter flight & protection provided in the event of a crash; I always feel safe. However, that may be due to placing my well being into the hands of others when I have confidence in their professional skills.	Any aid to survival should be taken	I would consider that the survival rate over water would be slightly higher than over land.
110	But felt safer just after 'downed' chopper about 2yrs ago, as I knew everyone would be more focused on maintenance/safety.		In my view the chances of survival are bad any way
116	Landing on a helideck with 60kt winds. One passenger on & one off holding onto a rope on your knees.	Some companies insist on 3 layers of clothing plus TIG, re-breather etc.	Safety should be the same over land or sea
117	Overseas		If you emergency land on water you can not just walk away
118	Less control on flying in bad weather conditions in the past.		
119	At no time have I ever felt unsafe. During a flight or whilst dealing with heli-ops.		The safety of the helicopter to me is far more important than the consideration of flying over land/water
122			Easier for emergency access
123			No difference to passengers in a crash on land or sea
125			If you crash at speed it makes no difference
126			Landing on water (if required) it's an issue regarding surviving
127		Re-breathers, can't see them being any use in helicopter ditch. It would be a panic situation.	
132	Continuing to upgrade		
134		Most people think when a chopper goes down no one will survive anyway!	
136	Stricter regulations	Safety equipment may one day save my life	An accident can happen over land or water
137	When first offshore not compulsory to wear survival suits or even lifejackets. Also nowadays re-breathers in use		Whether over water or land, if helicopter falls out of sky it is irrelevant what it hits
138	Trainings for escaping drowning helicopter provided, safety video is shown before flight, airpocket and swimsuit provided.		When helicopter crashes - it crashes

Ref No	Q3b	Q13	Q14
141	Chopper had to turn back to airport as a technical fault developed (Radar)	Perhaps a built-in lifejacket (all in one) would be more comfortable.	Flying over land or sea in my opinion should make no difference to safety
143	Better technology		Subconsciously safer (*OVER LAND)*
144			I would say it is a lot safer flying over land, if you can control the landing you have no chance of drowning.
145	I believe helicopters are inherently unsafe		Since a helicopter would drop like a stone, I think the difference is negligible
146	Helicopter Operators		
148			The helicopter should be safe whether travelling over water or land
149			A forced landing on land gives the opportunity to select a field, airfield, road etc. Over the sea conditions are more severe, sea temperature for example
150	Because of 76 accident		
151	Greater condition monitoring, better technology, tighter constraints on flying, operating conditions etc.		Safety of aircraft is same over land or water but risks increase over water in event of aircraft ditching
153	Not personally, but with equipment, systems and regulations that are in place, helicopters (and aviation) is now more safe.		However, I regard flights to offshore installations generally safer than other roles involving helicopters.
154	The vibration monitoring equipment is a major factor in preventing critical failures along with the constant improvement in material specifications.		
155	While in the forces seen things I did not find safe.		If you go down you go down
156			An irrelevant question as all crash sites are different
158		I am a pilot so as long as lifejacket is unrestrictive and I can still fly.	Survival times in water compare to land, liferafts increase time, slight discomfort.
159			Providing the aircraft can land location does not matter
163	I have previously flown in helicopters because of military service and offshore work but have never felt particularly unsafe in helicopters.	Slight discomfort is not a concern	If a helicopter can be landed under controlled conditions it is safer over land
164	Do not fly if sea state prevents rescue by standby boats.		

Ref No	Q3b	Q13	Q14
165			Survival time very minimal
166			It should not matter if flying over land/water - safety will still be same
168			Regardless where you fly, safety still matters
169	Advances in technology and the airworthiness of aircraft has improved dramatically	Dress to survive	Many years of flying over water, help isn't easily at hand should the event occur!
172	You very rarely hear of helicopter crashes or disasters		Special suits have to be worn when flying over water and you can't emergency land on water obviously.
173	Early days, ops pressure, management pressure dictating how engineers assess problems. Lack of investment in engineering depts.		Land and sea crashes have different factors which may affect survival of passengers/crew, both are equally important.
174	In the late 70's and early 80's the performance and equipment was sometimes marginal		Take offs and landings are the times when most incidents happen
175	Flying in industry for 5 yrs and safety has always been paramount and is constantly improving as focus is always on a safe and efficient operation.	Some items on life jackets do make flights uncomfortable over a long period of time. Eg. Personal beacons, flares	Hostile terrain or not should not have any bearing on operational safety
177			Low possibility of terrain collision
178	Less safe before HUMS systems were fitted		Water is not as flat as the land (in this country)
180	Earlier times and differing commercial pressures		Experience as a pilot. Walking away is easier than swimming away
181			Difficulty of rescue; possible rough sea state for ditching; cold temperatures; no protection from elements
182	We now have shallower cros-cockpit gradients; decision making by flight crew has become more conservative		Difficult to answer; onshore implies high density traffic and increased risk of CFIT; offshore accidents produce a consequential survival issue, but this has been mitigated by many initiatives in terms of safety equip/tng., HUMS, SAR, etc.
183			Recovery time can be lower and recovery made more difficult in water
184			Much less chance of CFIT
185	HUMS		Even a safe (ie. successful) landing on water exposes passengers and crew to the dangers of hypothermia and drowning

Ref No	Q3b	Q13	Q14
186			Because you can drown more easily
190	It's not necessarily a feeling, more a realisation that risks are better managed now and the industry is more highly regulated (at least in the N Sea area)		Survival/rescue time in the event of an emergency landing/ditching. "Cold shock"
191	Previous operation (still ongoing) was single-engine/single pilot/no AFCS over water, at night (overseas)		More regulated, better equipment & training, fewer obstructions, crews more experienced & qualified
193	Safety ongoing, therefore always feel as safe		
194	Improvements in technology allow improvements to safety programs, e.g. FDM/HUMS etc.	Life jackets could be made far more comfortable. Wide variety used on the Nsea - no standard	A ditching at sea is more hazardous than a forced landing onshore, but the helicopter doesn't know whether it's over sea or land
195		Air conditioning should be available in order to prevent heat exhaustion in summer which would be made worse if a full ditching occurred.	There is no ground to hit when low-level over water and obstructions are well-mapped.
196	Being in a helicopter with a large person next to you taking up half of your seat and blocking the exit that they will not fit through.	There is some good survival equipment out there (suits) the oil companies should spend some money and buy it.	If you make the crash landing on water you only have 3min without good suits.
197			In the event of a problem, there are obviously fewer places to land.
199	Prior to lightening strike on blade incident which was a factor in the incident at Norwich.		
200	Mainly because of the continuing safety researches		Whether flying over land or not safety should not be compromised.
201	Services are far more professional than 70's & helicopters newer.	The only reservation with British equipment is the comparative effectiveness between ours and Norwegian survival suits, Norwegial vastly superior.	Survivability in water after high impact landing marginally better than land.
202			I'd rather land in the water than hit the ground
204	Additions of HUMS to aircraft, advances in condition monitoring & lessons learned from many years of operation.		
205	At the first sign of a problem pilots return to base and sort it out.	Re-breather and PLB is uncomfortable but is important tool.	Softer landing (I Hope)
206	Everyone in the business is older now.		You can't drown on land.
207	Older aircraft, foreign locations with less stringent operating procedures.		
209	General improvement over time - new a/c,ROSS, HUMS, HOMP		Survival risks balanced by survival equipment, most critical failures do not respect environment.

Ref No	Q3b	Q13	Q14
211	Better survival suits, but cramped cabins, i.e., 18 people would be hard to exit in a crash.		No granite clouds. Therefore less flight into terrain incidents. Only recovery after an incident is more awkward.
212		Too cumbersome	If you can auto glide - better to land on something solid - not tip over in water.
213	Due to poor ergonomics and expanding waist sizes in the event of submersion I feel in some seats there is little chance of escape or use of equipment due to lack of space/movement.	As mentioned before due to lack of space and small exits in some cases do not believe it could be used!!	Do not believe in the controlled landing said to occur in briefs.
214	Advances in survival suits, self inflating gear (PPE)		
216		Safety equipment has to be accessible.	Flying over land or water is equally hazardous, wlthough the nature of the hazards are different.
217	One would expect safety elements to improve with technological advances and the increasingly more vigilant safety culture generally.		It would make a difference to the survival equipment carried but survival would depend upon the location and circumstances of the crash (& pilot skill).
218		There's too much safety equipment now; survival suit, lifejacket and location beacon. Don't like the idea re-breather.	Same risk applies over water (drowning hypothermia), land impact related injuries.
219			It is more important to stay airborne.
221	After any incident, but mainly after the Chinook incident off Shetland, which I was close to at the time and knew a number persons involved.		If you have a heavy landing water is still hard.
225		The new survival suits hurt the back of your neck	If your helicopter is safe, it does not matter where you fly land or sea.
226			Acceleration due to gravity is the same regardless of the surface flown over.
227	Introduction of new safety procedures and equipment.	Safety takes priority	9 times out of 10 helicopter will be able to land - added hazard of drowning & cold temps.
228	How would I know as a passenger if helicopters are more or less safe than before?		No difference for crash, but a landing (ditching) on water involves other hazards like hypothermia.
230	Only been offshore for 7 months but had no problems in regard to safety.	L.A.P Jacket is a bit sore on the back of the neck when it is a long flight.	The water is as hard when hitting at speed.
231		New lifejacket with built-in re-breather is very heavy	
233			Chances of survival in incident more or less the same, and down to individual's instincts.
236			Survivability in a crash is low on sea or land. Similarly a controlled landing is survivable.

Ref No	Q3b	Q13	Q14
237	No incidents in 15 years (personal?)	I don't believe the survival equipment brings much.	
239		High reliability of the aircraft has a greater importnace than survival equipment	As Q13 reliability & the prevention of incidents is paramount.
244	Flying in very bad weather, near miss in fog.		Helicopters can turn over on sea.
245	Advances in technology and reliability.		Rescue & recovery
246			If helicopter goes down it's going to break up wherever
248			Safety should be paramount whether over land or sea.
250	The time they flew Chinooks.	Very uncomfortable round the kneck, mind bending	There are advantages/disadvantages to both.
252			Purely because of difficulty of effecting a rescue.
254	Modern design & construction of a/c		
255			As long as all relevant precautions are taken and appropriate training provided, I feel safe.
256	Increased awareness in helicopter safety.		I don't see any real difference.
257	Helicopters are making several stops on different installations, resulting in more take-offs & landings, known to be the highest risk during flight.		Survival rate is low during any accident over water or land
258	Flying is now safer. There are still helicopter incidents, near misses, technical faults, and fatal crashes still occur. But, in the past, helicopters have been used which were uncomfortable, noisy & generally hated by the work force. I refer to Chinooks, and although numerous complaints were made, it took a fatal crash to take them out of service. Generally concerns are now acted on.		A helicopter flight should be safe no matter whether it is over land or water. Operators should be 100% sure that their aircraft are safe to fly anywhere.
259		Bulky & stiff lifejackets make for an uncomfortable journey which can last up to 2 hrs.	Height/speed/impact are the critical elements to survival in an aircraft failure.
260	More control and guidelines now as pre 1980's, ie. Pilots' flying hours, wind and sea states, weight restrictions, better maintenance, more emphasis on safety.		Over land and sea the safety remains paramount
261	Older aircraft, less reliable systems.		Relative impact of water/land obviously less, but drowning danger exists.

Ref No	Q3b	Q13	Q14
262	Mechanical faults cause stress. Bad weather conditions makes you worry a bit.	Easy access is more important than slight discomfort.	Once in the air, it makes no difference (land or sea).
264	Only been offshore for 1 year & therefore have not known different		falling from height into water or land doesn't matter, you're still going to die
265	Standards around helideck operations for boarding and dis-embarking are now tighter.	Survival equipment should be standardised across the industry	Falling from height have the same risks no matter what you are over.
266		3 layer policy + TIG suit + survival suit make travel very uncomfortable in crampt Tiger/Puma	Falling from circa 2000ft will result in same outcome.
268	Less known incidents or reported incidents in recent years.		It is the aircraft integrity that is key, no matter where it is flying
269	I did not feel safe flying in the Chinooks		
270		If the helicopter crashes mid flight I'm likely to be killed on impact, I'd rather be comfortable	Less places to land if minor problem occurs.
272			Even in a controlled ditching you may have to cope with bad sea states. Added risk once landed which does not occur over land.
273		The new lifejacket pull down neck, keep head from going back	If you crash, you crash
274	When flying in Chinook helicopters		Either way the chances of survival are minimum on both land or sea
275			I feel that if a helicopter crashes that it would not make much ods about was below.
276			There is a secondary accident hazard in drowning if you were to survive the crash.
277	Used to fly Chinooks, was on Cormorant Alpha crew when chopper went down.		Provided rotor are intact, it really makes no difference hitting water. From a great height, uncontrolled will be the same as land with *** difficulties
278	Flying in higher sea states years ago		
279	Does not seem to be so much incidents		Better chance of survival in accidents (water)
280			They can land at any time on land
281			In event of failure larger 'safe' area to land at short notice (over water)

Ref No	Q3b	Q13	Q14
282			less of an impact (water)
283		Life jacket too large, should be lighter and more compact	No matter where you're flying, safety is no.1 priority.
284	Up-to-date survival suits, communication, training	Three layer policy	If you have to ditch at sea you are not trying to avoid anything
285		Possible design changes would improve comfort	Falling from a great height hurts
286	Standards of offshore heli-crew competency & standard of operating company's maintenance & operations		My perception is less safe: although in reality I suspect there's probably no difference after surviving the impact whether you drown or survive the fire
288			Due to ditching/aircraft remaining upright/ rotor blade impacting water
289			Water provides its own hazards. Rescue access
290	I've never felt unsafe flying, but recognise that there has been continual improvement with training, safety equipment & procedues which has increased safety.	I do agree that it's more important to have survival equipment, but only if it is proven that it can help save your life in more than an obscure way.	Only rescue service may be very remote.
294	Before three months ago I had not been in a helicopter, so therefore I don't know how they used to be. But, I would think it is down to all personnel to ensure safety. There is occasional mechanical malfunction, but if no one cared for safety then indeed flying would be unsafe.	I would rather be slightly uncomfortable for a short while with a better chance of survival, than be comfortable with less chance of survival.	I would think it would be slightly safer than flying over land; would not crash on civilian buildings or streets, & with lifejackets & rafts hopefully our chance of survival would be better than hitting concrete.
295	Flying adverse weather, multiple take-off and landing on 'milk-run' flights. (less)	Lifejackets now incorporate air-pocket, very bulky. Would be awkward to get out of helicopter window in case of emergency.	If it hits water or land, it's still going to hurt
297	I would like to think helicopter travel is gettung safer every year.		If helicopter fails over land you can land quite easily.
298	I can't recall any occasion on a helicopter flight whereby I felt at risk	You'd want every available means of survival about you if an accident were to happen	If the helicopter was to crash I feel that it would be equipped to cope with either scenario
299	I am happy with the safety from 3 years ago until now. I have only been offshore for 3 years.	The safety equipment is required. Fact. Nothing can be done about it.	Risk of Fire reduced
300			If you crash from a height water is just as hard as land.
302		You seem to have to wear more and more clothing & equipment every year, making escape from helicopter more difficult	Survival percentage over water should be higher, but how long would you last in sea?
303	We as a helideck crew and as helicopter passengers feel confident in the helicopter operators, as this is the safest way to get from offshore to onshore each trip.	new lifejackets are uncomfortable	If flying over land and the engine gives way, the helicopter can auto gyrate and have a reasonable safe landing

Ref No	Q3b	Q13	Q14
304	Flying offshore on the morning of Tuesday 26th Feb 2006, the aircraft lifted from Bristows Aberdeen in white-out conditions. When other operators were not flying at that particular time.	The equipment/ re-breather is a bit bulky	If anything happened and a controlled landing was necessary, the pilots have the training to land the aircraft on land or water. But on water the sea state has a large influence on the safety of
305			There are greater safety aspects than whether over land or sea
306	I do feel they always err on the side of safety	It is just acceptable at present, but I wouldn't like to wear anything else!	Only if there was a low speed impact (safer)
308	Flying Chinook helicopters, 44 passengers with only 4 emergency exits, if the Chinook landed on the sea & turned over, there was 'no' chance of escape.		If a helicopter has to ditch, there is the possibility of it turning over, thus forcing people to try & escape - wouldn't happen on land.
309		Please make escape exits bigger	Both uncontrolled land & sea ditches are likely to end in death, controlled land ditches are slightly more safe.
310	Technology has improved over the last 25 years		Because of the stinginess of oil companies & government apathy, the flotation devices are still fitted in the wrong place, allowing aircraft to turn turtle in the slightest seas. These devices should be fitted where the weight is, I.e., engines & gearbox

Appendix E

Table for Work Decision Scenario with Individuals Who Believe Risk is Avoidable

Demonstrating Safety * Work Decision * Compromise * Regulatory System * Grounding * Accident Record * Regulatory Oversight * Express an Opinion * Safety Training * Accident Information Crosstabulation
Count

Accident Information		Safety Training		Express an Opinion		Regulatory Oversight		Accident Record		Grounding		Regulatory System		Compromise		Demonstrating Safety		Work Decision												Total
																		Helicopter Safety Important		S		More Important Factors		S		Should Safety Change for the Worse		S		R
Every Detail	2	Comprehensive	0	Very Important	2	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Self Regulation	0	Never	2	Absolute Priority	2	5	4	19	H		0	15			2	17		5
	2		0		2		1		2		2		0	Equal Obligation	0	Absolute Priority	2	1	4	17	J		0	13			2	15		1
	2		0		2		1		2		2	Light Regulation	1	Never	2	Absolute Priority	2		4	20			0	16		1	2	18	I	1
	2		0		2		1		2		2	Tight Regulation	2	Never	2	Absolute Priority	2	6	4	21	F		0	17		3	2	19	H	9
	2		0		2		1		2	Not-grounding to be justified	1	Self Regulation	0	Never	2	Absolute Priority	2	2	4	18	I		0	14			2	16		2
	2		0		2		1		2		1	Tight Regulation	2	Never	2	Absolute Priority	2	4	4	20	G		0	16		1	2	18	I	5
	2		0		2		1		2		1		2	Some	1	Absolute Priority	2	1	4	19	H		0	15			2	17		1
	2		0		2		1	Industry Record relevant	1	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Market Forces	0		4	18			0	14		1	2	16	K	1
	2		0		2	Market Forces Sufficient	0	Should be Published	2	Grounding rarely warranted	0	Light Regulation	1	Equal Obligation	0	Absolute Priority	2		4	15			0	11		1	2	13	N	1
	2		0		2		0	Industry Record relevant	1	Not-grounding to be justified	1	Self Regulation	0	Never	2	Absolute Priority	2	1	4	16	K		0	12			2	14		1
	2		0		2	Media Exposure more Important	0	Should be Published	2	Not-grounding to be justified	1	Self Regulation	0	Never	2	Absolute Priority	2	1	4	17	J		0	13			2	15		1
	2		0	Important	1	Tight Regulation Required	1	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Never	2	Market Forces	0	1	4	16	K		0	12			2	14		1
	2		0		1	Market Forces Sufficient	0	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Never	2	Market Forces	0	1	4	15	L		0	11			2	13		1
	2	Comprehensive but Chances Low	2	Very Important	2	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Light Regulation	1	Never	2	Absolute Priority	2		4	22			0	18		1	2	20	G	1
	2		2		2		1		2		2	Tight Regulation	2	Never	2	Absolute Priority	2	10	4	23	D	1	0	19	H	3	2	21	F	14
	2		2		2		1		2		2		2	Equal Obligation	0	Absolute Priority	2	1	4	21	F		0	17			2	19		1
	2		2		2		1		2		2		2	Some	1	Absolute Priority	2	1	4	22	E		0	18			2	20		1
	2		2		2		1		2	Not-grounding to be justified	1	Self Regulation	0	Never	2	Absolute Priority	2	1	4	20	G		0	16			2	18		1
	2		2		2		1		2		1	Light Regulation	1	Never	2	Absolute Priority	2	1	4	21	F		0	17			2	19		1
	2		2		2		1		2		1	Tight Regulation	2	Never	2	Absolute Priority	2	1	4	22	E		0	18			2	20		1
	2		2		2		1		2		1		2	Some	1	Absolute Priority	2		4	21			0	17		2	2	19	H	2
	2		2		2	Market Forces Sufficient	0	Should be Published	2	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2		4	22			0	18		1	2	20	G	1
	2		2		2		0		2	Grounding rarely warranted	0	Self Regulation	0	Never	2	Market Forces	0	1	4	16	K		0	12			2	14		1
	2		2		2	Media Exposure more Important	0	Should be Published	2	Not-grounding to be justified	1	Self Regulation	0	Never	2	Absolute Priority	2		4	19			0	15		1	2	17	J	1
	2		2	Important	1	Tight Regulation Required	1	Should be Published	2	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Absolute Priority	2		4	21			0	17		2	2	19	H	2
	2		2		1		1		2		1		2	Some	1	Absolute Priority	2		4	20		1	0	16	K		2	18		1
	2		2		1		1	Industry Record relevant	1	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Absolute Priority	2		4	20			0	16		1	2	18	I	1
	2		2		1		1	Publication Detrimental	0	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Absolute Priority	2	1	4	19	H		0	15			2	17		1
	2	Not Comprehensive	4	Very Important	2	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2	1	4	25	B		0	21			2	23		1
Main Points	1	Comprehensive	0	Very Important	2	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2		4	20			0	16		1	2	18	I	1
	1		0		2		1		2		2		2	Equal Obligation	0	Relative Parity	1	1	4	17	J		0	13			2	15		1
	1		0		2		1		2	Not-grounding to be justified	1	Light Regulation	1	Never	2	Absolute Priority	2	3	4	18	I		0	14			2	16		3
	1		0		2		1		2		1		1	Some	1	Absolute Priority	2	1	4	17	J		0	13			2	15		1
	1		0		2		1		2	Grounding rarely warranted	0	Tight Regulation	2	Some	1	Absolute Priority	2	1	4	17	J		0	13			2	15		1
	1		0		2		1	Industry Record relevant	1	Automatic Aircraft Grounding	2	Light Regulation	1	Never	2	Absolute Priority	2		4	18			0	14		1	2	16	K	1
	1		0		2		1		1	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Absolute Priority	2		4	18			0	14		1	2	16	K	1
	1		0		2		1		1		1		2	Some	1	Absolute Priority	2		4	17			0	13		1	2	15	L	1
	1		0	Important	1	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Light Regulation	1	Never	2	Absolute Priority	2	1	4	18	I		0	14			2	16		1
	1		0		1		1		2		2		1	Some	1	Absolute Priority	2		4	17		1	0	13	N		2	15		1
	1		0		1		1		2	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Absolute Priority	2	1	4	18	I		0	14			2	16		1
	1		0		1		1	Industry Record relevant	1	Not-grounding to be justified	1	Light Regulation	1	Never	2	Absolute Priority	2		4	16			0	12		1	2	14	M	1
	1		0		1	Market Forces Sufficient	0	Should be Published	2	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Relative Parity	1		4	16		1	0	12	O		2	14		1
	1		0		1		0		2	Grounding rarely warranted	0	Self Regulation	0	Never	2	Absolute Priority	2	1	4	14	M		0	10			2	12		1
	1		0		1		0	Publication Detrimental	0	Not-grounding to be justified	1	Light Regulation	1	Some	1	Absolute Priority	2		4	13		1	0	9	R		2	11		1
	1	Comprehensive but Chances Low	2	Very Important	2	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Light Regulation	1	Some	1	Absolute Priority	2	1	4	20	G		0	16			2	18		1
	1		2		2		1		2		2	Tight Regulation	2	Never	2	Absolute Priority	2	3	4	22	E		0	18		1	2	20	G	4
	1		2		2		1		2	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Absolute Priority	2		4	21			0	17		2	2	19	H	2
	1		2		2		1		2		1		2	Equal Obligation	0	Absolute Priority	2		4	19			0	15		1	2	17	J	1
	1		2		2		1		2		1		2	Some	1	Absolute Priority	2		4	20			0	16		1	2	18	I	1
	1		2		2		1	Industry Record relevant	1	Automatic Aircraft Grounding	2	Light Regulation	1	Some	1	Relative Parity	1		4	18			0	14		1	2	16	K	1
	1		2		2		1		1	Not-grounding to be justified	1	Tight Regulation	2	Some	1	Market Forces	0		4	17		1	0	13	N		2	15		1
	1		2		2		1	Publication Detrimental	0	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Market Forces	0		4	18			0	14		1	2	16	K	1
	1		2		2	Market Forces Sufficient	0	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Never	2	Market Forces	0		4	17			0	13		1	2	15	L	1
	1		2		2		0	Industry Record relevant	1	Grounding rarely warranted	0	Light Regulation	1	Some	1	Absolute Priority	2		4	16		1	0	12	O		2	14		1
	1		2	Important	1	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2	2	4	21	F		0	17		1	2	19	H	3
	1		2		1		1		2	Not-grounding to be justified	1	Light Regulation	1	Some	1	Absolute Priority	2		4	18			0	14		1	2	16	K	1
	1		2		1		1		2		1		1		1	Relative Parity	1		4	17			0	13		1	2	15	L	1
	1		2		1		1		2		1	Tight Regulation	2	Never	2	Absolute Priority	2		4	20			0	16		3	2	18	I	3
	1		2		1		1	Industry Record relevant	1	Automatic Aircraft Grounding	2	Light Regulation	1	Never	2	Absolute Priority	2	1	4	19	H		0	15			2	17		1
	1		2		1		1		1	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Absolute Priority	2		4	19			0	15		1	2	17	J	1
	1		2		1		1	Publication Detrimental	0	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2	1	4	19	H		0	15			2	17		1
	1		2	Unimportant	0	Tight Regulation Required	1	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Equal Obligation	0	Absolute Priority	2	1	4	16	K		0	12			2	14		1
	1		2		0	Market Forces Sufficient	0	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Some	1	Relative Parity	1		4	15			0	11		1	2	13	N	1
No Details	3	Comprehensive	0	Important	1	Tight Regulation Required	1	Industry Record relevant	1	Not-grounding to be justified	1	Light Regulation	1	Equal Obligation	0	Absolute Priority	2	1	4	16	K		0	12			2	14		1
	3	Comprehensive but Chances Low	2	Very Important	2	Tight Regulation Required	1	Industry Record relevant	1	Automatic Aircraft Grounding	2	Self Regulation	0	Never	2	Market Forces	0	1	4	19	H		0	15			2	17		1
	3		2	Important	1	Market Forces Sufficient	0	Industry Record relevant	1	Not-grounding to be justified	1	Light Regulation	1	Never	2	Relative Parity	1		4	18		1	0	14	M		2	16		1
	3	Not Comprehensive	4	Very Important	2	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2		4	26			0	22		1	2	24	C	1
																														109

Table for Work Decision Scenario with Individuals Who Believe that Risk is Unavoidable

Demonstrating Safety * Work Decision * Compromise * Regulatory System * Grounding * Accident Record * Regulatory Oversight * Express an Opinion * Safety Training * Accident Information Crosstabulation
Count

Accident Information		Safety Training		Express an Opinion		Regulatory Oversight		Accident Record		Grounding		Regulatory System		Compromise		Demonstrating Safety		Work Decision												Total
																		Helicopter Safety Important		S		More Important Factors		S		Should Safety Change for the Worse		S		R
Every Detail	2	Comprehensive	0	Very Important	2	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Self Regulation	0	Never	2	Absolute Priority	2	2	4	17	J	1	0	13	N	1	2	15	L	4
	2		0		2		1		2		2		0		2	Relative Parity	1	1	4	16	K	0	0	12		0	2	14		1
	2		0		2		1		2		2	Light Regulation	1	Never	2	Absolute Priority	2	1	4	18	I		0	14			2	16		1
	2		0		2		1		2		2	Tight Regulation	2	Never	2	Absolute Priority	2	7	4	19	H		0	15			2	17		7
	2		0		2		1		2		2		2	Equal Obligation	0	Absolute Priority	2	1	4	17	J		0	13			2	15		1
	2		0		2		1		2	Not-grounding to be justified	1	Light Regulation	1	Never	2	Absolute Priority	2	1	4	17	J		0	13			2	15		1
	2		0		2		1		2		1		1	Some	1	Absolute Priority	2	1	4	16	K		0	12			2	14		1
	2		0		2		1		2		1	Tight Regulation	2	Never	2	Absolute Priority	2	2	4	18	I		0	14		1	2	16	K	3
	2		0		2		1	Industry Record relevant	1	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2		4	18			0	14		1	2	16	K	1
	2		0		2		1		1	Not-grounding to be justified	1	Self Regulation	0	Never	2	Absolute Priority	2	1	4	15	L		0	11			2	13		1
	2		0		2		1		1		1	Light Regulation	1	Never	2	Absolute Priority	2	2	4	16	K		0	12		1	2	14	M	3
	2		0		2		1		1		1	Tight Regulation	2	Never	2	Absolute Priority	2		4	17			0	13		3	2	15	L	3
	2		0		2		1		1		1		2	Some	1	Absolute Priority	2	1	4	16	K		0	12			2	14		1
	2		0		2		1	Publication Detrimental	0	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Absolute Priority	2		4	16		1	0	12	O	1	2	14	M	2
	2		0		2	Market Forces Sufficient	0	Should be Published	2	Automatic Aircraft Grounding	2	Self Regulation	0	Never	2	Absolute Priority	2		4	16		1	0	12	O		2	14		1
	2		0		2		0		2		2	Light Regulation	1	Never	2	Absolute Priority	2	1	4	17	J		0	13			2	15		1
	2		0		2		0		2	Not-grounding to be justified	1	Self Regulation	0	Never	2	Absolute Priority	2	1	4	15	L		0	11			2	13		1
	2		0		2	Media Exposure more Important	0	Should be Published	2	Automatic Aircraft Grounding	2	Self Regulation	0	Some	1	Absolute Priority	2	1	4	15	L		0	11			2	13		1
	2		0		2		0		2	Not-grounding to be justified	1	Light Regulation	1	Equal Obligation	0	Market Forces	0	1	4	12	O		0	8			2	10		1
	2		0	Important	1	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2		4	18			0	14		1	2	16	K	1
	2		0		1	Market Forces Sufficient	0	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Never	2	Absolute Priority	2		4	15			0	11		1	2	13	N	1
	2		0	Unimportant	0	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Self Regulation	0	Some	1	Absolute Priority	2	1	4	14	M		0	10			2	12		1
	2	Comprehensive but Chances Low	2	Very Important	2	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Self Regulation	0	Never	2	Absolute Priority	2		4	19			0	15		2	2	17	J	2
	2		2		2		1		2		2	Light Regulation	1	Never	2	Absolute Priority	2	1	4	20	G		0	16			2	18		1
	2		2		2		1		2		2		1	Some	1	Absolute Priority	2	1	4	19	H		0	15			2	17		1
	2		2		2		1		2		2	Tight Regulation	2	Never	2	Absolute Priority	2	4	4	21	F		0	17		4	2	19	H	8
	2		2		2		1		2		2		2		2	Relative Parity	1	0	4	20			0	16		1	2	18	I	1
	2		2		2		1		2	Not-grounding to be justified	2	Self Regulation	0	Never	2	Absolute Priority	2	1	4	19	H		0	15		1	2	17	J	2
	2		2		2		1		2		2		0	Some	1	Absolute Priority	2	1	4	18	I		0	14			2	16		1
	2		2		2		1		2		2	Light Regulation	1	Never	2	Absolute Priority	2	1	4	20	G	1	0	16	K		2	18		2
	2		2		2		1		2		2	Tight Regulation	2	Never	2	Absolute Priority	2	2	4	21	F		0	17		6	2	19	H	8
	2		2		2		1		2		2		2	Some	1	Absolute Priority	2	1	4	20	G	0	0	16			2	18		1
	2		2		2		1		2		2		2		1	Relative Parity	1	0	4	19		2	0	15	L		2	17		2
	2		2		2		1		2	Grounding rarely warranted	0	Self Regulation	0	Some	1	Absolute Priority	2		4	16		1	0	12	O		2	14		1
	2		2		2		1		2		0	Tight Regulation	2	Some	1	Absolute Priority	2	1	4	18	I		0	14			2	16		1
	2		2		2	Market Forces Sufficient	0	Should be Published	2	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2		4	20			0	16		1	2	18	I	1
	2		2		2		0		2	Not-grounding to be justified	1	Light Regulation	1	Never	2	Absolute Priority	2		4	18		2	0	14	M		2	16		2
	2		2		2	Media Exposure more Important	0	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Never	2	Absolute Priority	2	1	4	18	I		0	14			2	16		1
	2		2		2		0		2		1		1	Equal Obligation	0	Market Forces	0		4	14			0	10		1	2	12	O	1
	2		2		2		0		2		1		1	Some	1	Absolute Priority	2		4	17			0	13		1	2	15	L	1
	2		2	Important	1	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Light Regulation	1	Never	2	Absolute Priority	2		4	19			0	15		1	2	17	J	1
	2		2		1		1		2		2	Tight Regulation	2	Never	2	Absolute Priority	2	1	4	20	G		0	16		2	2	18	I	3
	2		2		1		1		2		2		2	Equal Obligation	0	Absolute Priority	2		4	18			0	14		1	2	16	K	1
	2		2		1		1		2	Not-grounding to be justified	1	Light Regulation	1	Never	2	Absolute Priority	2		4	18			0	14		1	2	16	K	1
	2		2		1		1		2		1		1	Some	1	Absolute Priority	2		4	17			0	13		1	2	15	L	1
	2		2		1		1		2		1	Tight Regulation	2	Never	2	Absolute Priority	2	1	4	19	H	1	0	15	L	1	2	17	J	3
	2		2		1		1		2	Grounding rarely warranted	0	Self Regulation	0	Some	1	Relative Parity	1		4	14		1	0	10	Q		2	12		1
	2		2	Unimportant	0	Market Forces Sufficient	0	Should be Published	2	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2		4	18		1	0	14	M		2	16		1
	2		2		0		0	Industry Record relevant	1	Grounding rarely warranted	0	Light Regulation	1	Some	1	Relative Parity	1		4	12		1	0	8	S		2	10		1
	2		2		0	Media Exposure more Important	0	Should be Published	2	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Market Forces	0		4	16			0	12		1	2	14	M	1
	2	Not Comprehensive	4	Very Important	2	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2	1	4	23	D		0	19			2	21		1
	2		4		2		1	Industry Record relevant	1	Not-grounding to be justified	1	Light Regulation	1	Never	2	Absolute Priority	2		4	20			0	16		1	2	18	I	1
	2		4		2	Media Exposure more Important	0	Should be Published	2	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Market Forces	0		4	20			0	16		1	2	18	I	1
Main Points	1	Comprehensive	0	Very Important	2	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Self Regulation	0	Some	1	Absolute Priority	2		4	15		1	0	11	P		2	13		1
	1		0		2		1		2		2	Light Regulation	1	Never	2	Absolute Priority	2	1	4	17	J		0	13			2	15		1
	1		0		2		1		2		2		1	Some	1	Absolute Priority	2	1	4	16	K		0	12			2	14		1
	1		0		2		1		2		2	Tight Regulation	2	Never	2	Relative Parity	1	1	4	17	J		0	13			2	15		1
	1		0		2		1		2	Not-grounding to be justified	1	Self Regulation	0	Never	2	Absolute Priority	2	1	4	15	L		0	11			2	13		1
	1		0		2		1		2		1	Light Regulation	1	Never	2	Absolute Priority	2	2	4	16	K	1	0	12	O	0	2	14		3
	1		0		2		1		2		1		1		2	Market Forces	0	0	4	14		0	0	10		1	2	12	O	1
	1		0		2		1		2		1		1	Some	1	Absolute Priority	2	1	4	15	L		0	11			2	13		1

Table for Work Decision Scenario with Individuals Who Believe that Risk is Unavoidable

Accident Information		Safety Training		Express an Opinion		Regulatory Oversight		Accident Record		Grounding		Regulatory System		Compromise		Demonstrating Safety		Work Decision												Total
																		Helicopter Safety Important		S		More Important Factors		S		Should Safety Change for the Worse		S		R
	1		0		2		1		2		1	Tight Regulation	2	Never	2	Relative Parity	1		4	16			0	12		1	2	14	M	1
	1		0		2		1		2	Grounding rarely warranted	0	Light Regulation	1	Equal Obligation	0	Market Forces	0		4	11			0	7		1	2	9	R	1
	1		0		2		1	Industry Record relevant	1	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2		4	17			0	13		1	2	15	L	1
	1		0		2		1	Publication Detrimental	0	Not-grounding to be justified	1	Tight Regulation	2	Some	1	Absolute Priority	2		4	14			0	10		1	2	12	O	1
	1		0		2	Market Forces Sufficient	0	Should be Published	2	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Absolute Priority	2	2	4	16	K		0	12			2	14		2
	1		0		2	Media Exposure more Important	0	Publication Detrimental	0	Automatic Aircraft Grounding	2	Tight Regulation	2	Equal Obligation	0	Market Forces	0	1	4	11	P		0	7			2	9		1
	1		0	Important	1	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Self Regulation	0	Never	2	Absolute Priority	2		4	15			0	11		1	2	13	N	1
	1		0		1		1		2		2	Light Regulation	1	Never	2	Relative Parity	1		4	15			0	11		1	2	13	N	1
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	1		0		1		1		2	Grounding rarely warranted	0	Self Regulation	0	Never	2	Absolute Priority	2		4	13		1	0	9	R		2	11		1
	1		0		1		1	Industry Record relevant	1	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Market Forces	0		4	14			0	10		1	2	12	O	1
	1		0		1		1		1	Not-grounding to be justified	1	Light Regulation	1	Some	1	Relative Parity	1		4	12		1	0	8	S		2	10		1
	1		0		1		1	Publication Detrimental	0	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Market Forces	0	1	4	12	O		0	8			2	10		1
	1		0		1	Market Forces Sufficient	0	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Some	1	Absolute Priority	2		4	13			0	9		1	2	11	P	1
	1	Comprehensive but Chances Low	2	Very Important	2	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Self Regulation	0	Never	2	Absolute Priority	2	1	4	18	I		0	14			2	16		1
	1		2		2		1		2		2	Light Regulation	1	Never	2	Absolute Priority	2	1	4	19	H		0	15			2	17		1
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	1		2		2		1		2		2	Tight Regulation	2	Never	2	Absolute Priority	2		4	20			0	16		1	2	18	I	1
	1		2		2		1		2	Not-grounding to be justified	1	Self Regulation	0	Never	2	Absolute Priority	2		4	17			0	13		1	2	15	L	1
	1		2		2		1		2		1	Light Regulation	1	Never	2	Absolute Priority	2		4	18			0	14		1	2	16	K	1
	1		2		2		1		2		1		1	Equal Obligation	0	Relative Parity	1		4	15			0	11		1	2	13	N	1
	1		2		2		1		2		1	Tight Regulation	2	Never	2	Absolute Priority	2	4	4	19	H		0	15		1	2	17	J	5
	1		2		2		1		2		1		2		2	Relative Parity	1	1	4	18	I		0	14		0	2	16		1
	1		2		2		1		2		1		2	Equal Obligation	0	Absolute Priority	2	1	4	17	J		0	13			2	15		1
	1		2		2		1		2		1		2	Some	1	Absolute Priority	2	1	4	18	I	0	0	14			2	16		1
	1		2		2		1		2		1		2		1	Relative Parity	1	0	4	17		1	0	13	N		2	15		1
	1		2		2		1	Industry Record relevant	1	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Absolute Priority	2	0	4	19			0	15		1	2	17	J	1
	1		2		2		1		1		2		2		2	Relative Parity	1	1	4	18	I		0	14		0	2	16		1
	1		2		2		1		1	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Absolute Priority	2		4	18		1	0	14	M	1	2	16	K	2
	1		2		2		1		1		1		2	Some	1	Relative Parity	1	1	4	16	K		0	12			2	14		1
	1		2		2		1	Publication Detrimental	0	Not-grounding to be justified	1	Tight Regulation	2	Some	1	Absolute Priority	2		4	16		1	0	12	O		2	14		1
	1		2		2	Market Forces Sufficient	0	Should be Published	2	Automatic Aircraft Grounding	2	Light Regulation	1	Never	2	Absolute Priority	2		4	18			0	14		1	2	16	K	1
	1		2		2		0		2	Not-grounding to be justified	1	Light Regulation	1	Equal Obligation	0	Absolute Priority	2	1	4	15	L		0	11			2	13		1
	1		2	Important	1	Tight Regulation Required	1	Should be Published	2	Automatic Aircraft Grounding	2	Self Regulation	0	Never	2	Absolute Priority	2	1	4	17	J		0	13		1	2	15	L	2
	1		2		1		1		2		2	Light Regulation	1	Never	2	Market Forces	0		4	16			0	12		1	2	14	M	1
	1		2		1		1		2		2	Tight Regulation	2	Never	2	Absolute Priority	2		4	19			0	15		2	2	17	J	2
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	1		2		1		1		2		2		2	Equal Obligation	0	Absolute Priority	2	1	4	17	J		0	13			2	15		1
	1		2		1		1		2		2		2	Some	1	Relative Parity	1		4	17			0	13		1	2	15	L	1
	1		2		1		1		2	Not-grounding to be justified	1	Light Regulation	1	Never	2	Absolute Priority	2		4	17		2	0	13	N		2	15		2
	1		2		1		1		2		1		1	Some	1	Absolute Priority	2	1	4	16	K	0	0	12			2	14		1
	1		2		1		1		2		1		1		1	Relative Parity	1	0	4	15		1	0	11	P		2	13		1
	1		2		1		1		2		1	Tight Regulation	2	Never	2	Absolute Priority	2		4	18			0	14		2	2	16	K	2
	1		2		1		1		2		1		2		2	Relative Parity	1		4	17			0	13		1	2	15	L	1
	1		2		1		1		2		1		2	Equal Obligation	0	Relative Parity	1		4	15			0	11		1	2	13	N	1
	1		2		1		1		2		1		2	Some	1	Absolute Priority	2		4	17			0	13		1	2	15	L	1
	1		2		1		1	Industry Record relevant	1	Not-grounding to be justified	1	Tight Regulation	2	Some	1	Relative Parity	1		4	15			0	11		1	2	13	N	1
	1		2		1	Market Forces Sufficient	0	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Some	1	Relative Parity	1		4	14		1	0	10	Q		2	12		1
	1		2		1		0		2		1	Tight Regulation	2	Some	1	Absolute Priority	2		4	16			0	12		1	2	14	M	1
	1		2		1		0	Industry Record relevant	1	Not-grounding to be justified	1	Self Regulation	0	Never	2	Absolute Priority	2		4	14			0	10		1	2	12	O	1
	1		2		1	Media Exposure more Important	0	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Some	1	Relative Parity	1		4	14			0	10		1	2	12	O	1
	1		2	Unimportant	0	Tight Regulation Required	1	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Never	2	Absolute Priority	2		4	16			0	12		1	2	14	M	1
	1		2		0	Market Forces Sufficient	0	Should be Published	2	Automatic Aircraft Grounding	2	Tight Regulation	2	Never	2	Market Forces	0		4	15			0	11		1	2	13	N	1
	1		2		0		0		2	Not-grounding to be justified	1	Light Regulation	1	Equal Obligation	0	Market Forces	0		4	11		1	0	7	T		2	9		1
	1		2		0		0		2		1		1	Some	1	Market Forces	0	1	4	12	O		0	8			2	10		1
	1	Not Comprehensive	4	Very Important	2	Market Forces Sufficient	0	Should be Published	2	Not-grounding to be justified	1	Tight Regulation	2	Some	1	Absolute Priority	2	1	4	19	H		0	15			2	17		1
	1		4		2	Media Exposure more Important	0	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Equal Obligation	0	Relative Parity	1	1	4	16	K		0	12			2	14		1
	1		4	Important	1	Media Exposure more Important	0	Should be Published	2	Not-grounding to be justified	1	Light Regulation	1	Some	1	Relative Parity	1	1	4	16	K		0	12			2	14		1
	1		4	Unimportant	0	Market Forces Sufficient	0	Industry Record relevant	1	Not-grounding to be justified	1	Light Regulation	1	Some	1	Relative Parity	1		4	14			0	10		1	2	12	O	1
Who is to Blame	0	Comprehensive but Chances Low	2	Important	1	Market Forces Sufficient	0	Publication Detrimental	0	Grounding rarely warranted	0	Light Regulation	1	Some	1	Relative Parity	1		4	10		1	0	6	U		2	8		1
No Details	3	Comprehensive	0	Important	1	Tight Regulation Required	1	Industry Record relevant	1	Not-grounding to be justified	1	Self Regulation	0	Never	2	Market Forces	0		4	13		1	0	9	R		2	11		1
Don't Know	0	Comprehensive but Chances Low	2	Important	1	Media Exposure more Important	0	Should be Published	2	Not-grounding to be justified	1	Tight Regulation	2	Never	2	Market Forces	0		4	14		1	0	10	Q		2	12		1
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