CRANFIELD UNIVERSITY

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SAFETY CULTURE: A LEGAL STANDARD FOR COMMERCIAL AVIATION

School of Aerospace, Transport and Manufacturing

PhD

Academic Year: 2011 - 2017

Supervisor: Professor Graham Braithwaite
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ABSTRACT

Although a link between organisational safety culture and human behaviour is well established within academic literature, ambiguity about the actual nature of the causal relationship has inhibited its practical application. This thesis aims to establish a legal standard of safety culture by producing a model which describes the relationship between organisational safety culture and potential corporate liability. The model, called d3SC, attempts to promote a defence of due diligence to potential prosecution by improving an organisation's safety culture.

The thesis consists of three sequential studies. The first study comprises of twenty-six accident case studies from which data is developed into a prototype model through a process of grounded theory. The subsequent studies then take the emergent model from a construct to a risk management tool that was applied and tested against a real-world data from commercial aviation and law. In attempting to develop a model, d3SC, the thesis has adopted a predominantly functionalist approach. However, it is recognised that the complexities of culture and causation are not sufficiently represented without adopting some methods of real world analysis.

This recognition of the need to dig deeper into organisational dynamics is manifest in the use of qualitative methods in the thesis to triangulate the output of the d3SC process. It is also represented in the units of measurement or case studies from which safety culture is frequently described. The quality of safety culture is often described in terms of organisational performance yet a consistent theme in both the literature and the data collated in these studies, shows that aggregating organisational safety culture as a singular measurement can be misleading. Contrasting the data from different departments and hierarchical levels within an organisation gives a much deeper and contextual understanding of internal dynamics and influences. This is of particular relevance to corporate liability in the aftermath of an accident. Prosecuting agencies will not focus their investigation on the adequacy of overall metrics of organisational assessments, but on the perceived causal links between an accident and the weaker areas of organisational safety culture. By improving the visibility and understanding of the causal links between corporate liability and corporate culture it is hoped that this research can contribute to enhancing safety standards in commercial aviation.

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A big thank you to my children, Albert, Iris, Abigail and Joe for their love and understanding over the last six years whilst I wasn't always there to be Dad. However, the biggest thanks are due to my amazing partner, Vicky. Without her constant understanding, love and support it really wouldn't have been possible.

Finally, my mother Maureen, to whom this thesis is dedicated. Taken from us far too early but with an inspiring and lingering legacy; just go for it!

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Lawrenson, A. J., & Braithwaite, G. R. (2018) '*Regulation or criminalisation: What determines legal standards of safety culture in commercial aviation?*', Safety Science, 102, 251-262

LIST OF ABBREVIATIONS

AAIB	Air Accident Investigation Branch
ALARP	As Low As is Reasonably Practicable
ALOS	Acceptable Level of Safety
ANSV	Agenzia Nationale Per La Sicurrezza Del Volo (Air Accident Investigation Italy)
ANO	Air Navigation Order (UK)
ATC	Air Traffic Control
ATSB	Australian Transport Safety Bureau
BEA	Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (Air Accident Investigation, France)
BFU	Bundesstelle für Flugunfalluntersuchung (Air Accident Investigation, Germany)
BP	British Petroleum (historic name of BP Plc)
CAA	Civil Aviation Authority (UK)
CAP	Civil Aviation Publication
CAIB	Colombia Accident Investigation Board
CENIPA	Centro de Investigação e Prevenção de Acidentes Aeronáuticos (Air Accident Investigation, Brazil)
CIAIAC	Comisión de Investigación de Accidentes e Incidentes de Aviación Civil (Air Accident Investigation, Spain)
CMCHA	The Corporate Manslaughter & Corporate Homicide Act 2007 (UK)
CPS	The Crown Prosecution Service (UK)
CSE	Cognitive Systems Engineering

CURES	Cranfield University Research Ethics System
d3SC	Defence of Due Diligence Through Safety Culture
DGAC	Dirección General de Aviación Civil (Civil Aviation Regulator, France)
DOJ	Department of Justice (US)
DOT	Department of Transportation (US)
EASA	European Aviation Safety Authority
EU	European Union
FAA	Federal Aviation Authority (US)
FOCA	Federal Office of Civil Aviation (Switzerland)
FSF	Flight Safety Foundation
GAO	Government Accountability Office (US)
GPWS	Ground Proximity Warning System
HFACS	Human Factors Accident Classification System
HRO	High Reliability Organisations
HRT	High Reliability Theory
HSE	Health and Safety Executive (UK)
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
INSAG	International Nuclear Safety Group
LJ	Lord Justice (UK)
MP	Member of Parliament (UK)
NAA	National Aviation Authority
NASA	National Aeronautics and Space Administration

NAT	Normal Accident Theory
NHS	National Health Service
NTSB	National Transport Safety Board (US)
OECD	Organisation for Economic Co-operation and Development
ORR	Office of Rail and Road (UK)
PD	Power Distance
QC	Queens Counsel
RAF	Royal Air Force
RESA	Regulation and Enforcement Act 2008 (UK)
SMM	Safety Management Manual
SMS	Safety Management System
SOP	Standard Operating Procedures
TEPCO	Tokyo Electric Power Company
UA	Uncertainty Avoidance
UK	United Kingdom
US	United States (of America)

1 INTRODUCTION

Recent theories concerning aviation safety have tended to adopt systems-based perspectives rather than traditional quantitative analyses of safety performance. Relying on constructs such as organisational culture, the focus on system safety reflects a broader shift in societal risk perceptions. Previously reliant on long-standing governmental and non-governmental organisations for sense-making data, modern societal attitudes have seen a lessening of trust in traditional establishments. This deterioration in the psychological contract between the individual and the state on which many of the mechanisms of governance were dependent has opened a debate as to what level of intervention the legal system should adopt in managing and regulating safety in commercial aviation.

For all its ingenuity in balancing the vastly complex vagaries of human behaviour, the law also carries with it considerable risk in exposing sections of society to perceived injustice. One result of this process has been the criminalisation of air accidents; initially focussed on the operating individuals but now increasingly directed towards the conduct of the organisations which have trained and moulded operating standards. The rise in prominence and change in nature of the corporate body presents significant challenges to the world's legal systems. The sheer size and administrative complexity of some modern corporations present the law with increasing societal demands on how to constrain corporate malfeasance, particularly when the corporate use of new technologies results in multi-fatality accidents. Corporate crime sits outside of moral standards associated with mainstream criminality and therefore normative assumptions about the nature of criminal activity do not adapt easily to the complexity of corporate governance techniques and managerial structures.

Highlighted against this emerging landscape of safety and risk management was the intimacy with which the general public experienced the carnage of the Shoreham Air Show crash which occurred in the UK on the 22nd August 2015. A historic aircraft, a Hawker Hunter T7 jet fighter, struck part of the A27 westbound carriage during an aerobatic display. Eleven people on the ground who had little or no connection with the air show were killed. Although not a mainstream commercial aircraft accident, the event highlights some of the evolving issues of accident causation. Multiple sources of high

quality video recording devices held by the public (and operated by the pilot himself within the cockpit), provide an unprecedented volume of information. The wealth of data might lead us to the assumption that repeated system failures could be more effectively avoided and therefore safety performance enhanced. However, the accelerated use of incident recording through various species of electronic recording devices, presents new and complex issues. One of these is the speed and magnitude of social reaction. This rapid distribution of imagery, promotes an emotive societal reaction, unfiltered and unedited by the traditional mechanisms of media establishment; the cause of the accident seems obvious. However, the all-too-often short search to determine the direct causal link between the accident and the human operator, (that is anyone with a close physical and temporal link to the accident), is progressively being supplemented by further causal associations. These causal associations align with the focus of safety research on the influence of safety culture on organisational safety performance.

This association is an embryonic area of law but one which carries considerable socio-political currency. When presented with the powerful imagery and unedited descriptions of commercial aviation accidents, society has collective and overwhelming need to understand why such events occur. A powerful medium used by governments to explain failures in aviation safety has been official air accident reports. Reading air accident investigation reports or case law reports which describe organisational failure, can provide only a limited explanation of why an event occurred. Unless the context of the decision-making process surrounding an accident is encapsulated within the report, the most significant motivators in human decision making are overlooked, (Morley & Stuart, 2014). Social engineering in all its forms cannot progress without a clear understanding of how we arrived at our individual or collective decisions within the social context that they emerged, (Klein, 1998; Kahneman, 2011). On this basis, the significance of organisational safety culture has grown to become a highly significant concept with which accident causation in complex systems can be explained. Without knowing what influencing drivers brought and individual, a collective or a whole organisation to a position of normalising what proved, *post hoc*, to be illogical, risky or plainly dangerous, any investigation can only attempt to describe an event, but not why or how this event happened. However, retrospectively establishing a correlation between poor safety

culture and organisational failure is very different to establishing a legal or scientifically credible causal link between safety culture and future safety performance.

The AAIB (2017), report on the Shoreham air show crash, highlights another significant feature of the contemporary safety management landscape. The reports describe a heavy reliance on prescriptive regulation whilst paying minimal regard to more fundamental attitudes of safety management. According to the AAIB report, the show's organisers were heavily focussed on CAA regulatory compliance whilst the CAA appeared to have based their safety case largely on the perceived experience of the flying display's director. Appendix J to the AAIB report candidly describes the risk assessment as 'not fit for purpose'. The report suggests that both the regulator and operator had lost perspective on what the air show's safety case was supposed to achieve. The most vulnerable social group, who had been identified by risk assessment were third party spectators gather along the A27 adjoining the airfield, i.e. those outside of the direct control of the organisers. Yet, in their efforts to control the display's pattern away from onsite spectators and achieve regulatory compliance, they had inadvertently subjected people offsite to an inappropriately high level of risk. A requisite legal standard of safety culture may have helped to address this lost perspective on safety and risk by focussing attention on the magnitude of potential liability rather than taking comfort in the low probability of an actual catastrophe.

1.1 Motivation for Study

Culture is powerful. During a re-union of my ex-colleagues from military service we reminisced about our early days in the RAF. We also talked about what used to frightened us the most; it wasn't about being killed in an accident but of failing our flying training. The somewhat perverse culture of military flying training afforded the victims of fatal accidents instantaneous status and credibility whilst in contrast, being 'chopped' was an ignominious exit from an exciting and prestigious career. It might seem from the outside of that very intense culture, that this was simply the output of young male machoism but the squadron walls, festooned with black and white photographs of young faces with halos (for those killed) and axes (for those chopped), were there to re-enforce the message that despite the risks, failure was not an option.

On the 27th May 1993, a fatal accident involving friends and work colleagues re-enforced how culture penetrated every aspect of the way we operated. During a training exercise, a C-130K Hercules stationed at Royal Air Force Lyneham hit the ground near Blair Athol in the Scottish Highlands. All nine crew members were killed on impact. The aircraft was carrying out a low level and low speed manoeuvre in mountainous terrain known for significant turbulence. Carrying out low speed manoeuvres at low level in this area raised questions by the accident investigation team but the RAF Hercules world had always operated that way in this type of terrain. There was sufficient knowledge and experience to recognise the threat from low level turbulence; another Hercules flown by the writer had almost hit the ground in the same valley some three months previous to the fatal accident. However, the system and the culture didn't learn from its collective experiences.

The military accident investigation team investigating the fatal crash concluded that the aircraft stalled from a height from which a recovery was impossible. Any potential recovery would have involved the application of full power to increase flying speed from increased thrust and to increase airflow from the turbo-prop engines over the lift-starved wings. Seconds before impact the flight crew had set the rigorously enforced 18,000 pounds of torque on all four of the powerful engines. They did this despite more power being available (up to 19,600 pounds of torque and probably more had the engine's thrust levers been pushed fully forward). Throughout iterative training in the simulator and on the aircraft, 'over-torqueing' the aircraft was a complete 'no-no' and became culturally embedded into our operation. Although 19,600 pounds was the manufacturer's limitation, a limit of 18,000 pounds of torque was imposed to give a buffer against engine damage from over-enthusiastic pilots. Speculation amongst the deceased's colleagues, who were familiar with Hercules operation, reflected that even when faced with flying into the ground, the behavioural norms engraved through years of rigorous training ultimately determine our actions. Culture is powerful.

My more recent experience in commercial aviation has seen the influence of commercial pressure more than occasionally conflicting with safety and risk decision-making processes. Although the owners and operators of commercial airlines continually strive to maintain high standards of operation, the purity of the message that safety comes first seems to be watered down as it tracks down through the complex hierarchy of airline

bureaucracy. Middle management decision territory is a culture of constant compromise between acceptable levels of safety and increasing requirements for improved efficiencies. It is in this area that prescriptive regulatory law becomes inadequate and the need for a requisite level of safety culture is most needed. Safety theorists often talk about systems thinking; in commercial aviation, the *systems* are generally robust, it's the culturally driven *thinking* that needs to be managed.

1.2 Research Rationale

Although considerable research has been carried out on defining and quantifying safety culture, the aim of this study is to identify and assess the feasibility of adapting a legal standard of safety culture to the complex regulatory structure of commercial aviation. This study will concentrate predominantly on the jurisdictions of the United Kingdom[1], which is still adapting to the enactment of the Corporate Manslaughter and Corporate Homicide Act (CMCHA) 2007. To address the issue of work related fatalities, many other common law systems, particularly Australia and Canada have followed similar strategies to the UK. However, many parallels can be drawn with other civil law and hybrid jurisdictions, so scope exists to develop other country or regional specific variants of the study's outcomes. Because of our increasing dependency on and developing threats from new technologies, societal risk sharing is increasingly promoted through legal systems. To maintain its own credibility as an effective instrument of societal risk management, the law has to be able to demonstrate it can adapt to these new threats and provide an effective deterrent against their proliferation. As a matter of public policy, the heavy financial penalties that the CMCHA can invoke cannot be insured against, and as it is the corporate body itself that is judged, prosecution would not extend to individuals within the organisation[2]. The UK's corporate criminal law now provides a potential financial incentive to safety critical industries to maintain not only minimal legal compliance, but also an enhanced, resilient and dynamic safety culture.

[1] Within the UK there are three main jurisdictions: England and Wales, Scotland and that of Northern Ireland. The CMCHA explicitly encompasses all three jurisdictions but other areas of statute law may not have universal application across the whole of the UK.
[2] Although individuals associated with a corporate prosecution could face separate charges associated with their individual criminal liability.

This study considered not only the extent to which safety culture is recognised as a causal element within the field of safety science but also how its constituent elements and system perspective is reflected in recent developments in corporate criminal law. The significance of this legal development is crucial to how corporations could be motivated to continually improve safety standards in commercial aviation. Whilst accident figures are relatively low, decisions about the allocation of safety resources are based on ultra-low probabilities, this is particularly the case if accident probability is contained to one organisation. However, with increasing dependency on corporately controlled new technologies, societal risk sharing is increasingly promoted through legal mechanisms such as the CMCHA which aim to encourage corporate diligence. The legal system has to consider public confidence in commercial aviation rather than simply whether accident statistics are maintained at an industry defined acceptable level of attrition.

1.3 Hypothesis

The mechanisms of corporate safety culture and corporate criminal liability have become sufficiently aligned to enable the development of a practical risk management tool which could enhance safety culture and mitigate the impact of a potential prosecution for corporate manslaughter.

1.4 Basis of Hypothesis

As this study aims to look at a legal standard of safety culture, a substantial amount of initial research focussed on legal causation theory and on case law. The initial hypothesis considered the possibility of an exotic species of causation that could encapsulate the various concepts of safety culture and therefore derive elements of corporate liability. Occasionally, progressive variants of legal causation have emerged in case law, such as *Fairchild v Glenhaven*[3]. This case concerned the extent of liability of multiple employers who had collectively and negligently over a period of many years, allowed their employees to be exposed to asbestos. The court had to reconcile the obvious injustice of the case with legal mechanisms of causation. *Fairchild v Glenhaven* represents a landmark case in a progressive evolution in corporate liability. According to Hart & Honoré (1985) the reason for this causal evolution has more positivist links with socio-political motives rather than interpretative notions of legal liability. The changing socio-political motives referred to by Hart & Honoré extend to increasing social focus on organisational rather than individual malfeasance. A considerable body of literature associates the safety performance of an organisation with the nature or quality of the organisation's safety culture, (Guldenmund, 2000; Cooper, 1997). The common thread of these theories would appear to be that the absence of an effective safety culture inhibits an organisation's ability to identify emergent threats, adapt and ultimately react in time to avoid catastrophe, (Reason, 1997; Senge, 2006; Hale, Guldenmund, Van Loenhout, & Oh, 2010). Recognising the potential of safety culture is one thing but defining and quantifying a requisite standard or even common definition of safety culture has proved to be something of an elusive goal, (Guldenmund, 2000; Cooper, 2000; Neilson, 2013). The ambiguity surrounding the nature of safety culture has not impeded its progression

[3] [2002] UKHL 22

from a concept towards a construct. It is the ambiguity of safety culture which provides the very latitude safety management needs to describe an all-encompassing concept of organisational best practice, (Wahlstrom & Rollenhagen, 2009). However, if safety culture is to progress towards more practical utility in order to influence safety performance, then some form of basic theoretical framework is necessary. Hale (2000), suggests that by placing the concept of safety culture within a broader model of organisational culture, then progression towards the management of safety performance through safety culture can continue. This study intends to pursue this initial objective; the theoretical direction is predominantly derived from the work of Edgar Schein, (1996) and in particular, his concept of a three-tier model of organisational culture. Schein's theory provided the foundation of many contemporary conceptual variations of safety culture. In reflecting on this later work, Schein (2017) suggests that it has become necessary to reflect on the anthropological basis of cultural theory before further adaptation loses the original theoretical context. In a bid to provide a benchmark for the regulatory monitoring of safety culture performance, some safety culture metrics have adopted simplified versions of the original concept of organisational culture. Schein (2017) reminds us of the need to understand the highly contextual nature of culture and in order to develop our understanding of the dynamics within it, many of the deeper explanatory research techniques of anthropology are necessary.

1.5 Research Question

To what extent can legal standards of safety culture be identified and applied to the field of commercial aviation?

Objectives:

I. To consider the extent to which the mechanisms of corporate liability and corporate safety culture have become aligned.

II. Develop a self-assessed, evidence-based risk management tool, with which organisations can enhance their safety culture as a pre-emptive defence against a potential prosecution of corporate manslaughter.

III. Assess the utility and legal credibility of a risk management tool that interprets the quality of safety culture and measures the potential liability of an organisation engaged in commercial aviation.

1.6 Structure of the Thesis

As described in *Figure 1* the thesis is structured as three sequential studies; each is a discrete piece of research which builds on the outcome of the previous study. The thesis aims to align theoretical concepts from numerous academic fields but is predominantly focussed on combining those closely associated with organisational culture and legal causation.

Study One (Chapter Three): The study collated multiple accident reports, investigations and legal case studies linking attributes of safety culture to accident causation. A process of grounded theory was then followed which produced a model which incorporated a generic model of organisational structure and causal function. The model consisted of nine attributes of safety culture; the scoring system produced an estimate of potential corporate liability. The score is intended to incentivise an improve safety culture as a pre-emptive defence of due diligence or d3SC. The model was designed to ease the theoretical strain between pursuing the positivist tradition and understanding the more detailed and complex influences within organisations, promoted by, *inter alia,* Schein (2017).

Study Two (Chapter Four): This study tested and developed a prototype d3SC model produced in Study One. A Likert questionnaire was used to collate safety culture data. The next challenge was to translate the output of the questionnaire into the d3SC model whilst maintaining the context of the participants responses. A three-phase pilot study was conducted. The first phase assessed a safety culture known to the researcher, the second used multiple safety cultures unknown to the researcher and the third interpreted the formal reports from twenty-six high profile accidents.

Study Three (Chapter Five): The study used d3SC to assess the safety culture and associated corporate liability of a commercial aviation organisation. The sensitive nature of research subject required the researcher to establish a relationship of trust with the organisation before research could begin. As such the study took over eighteen months and three phases to collect the data. The study was the first to use d3SC to assess multiple participants views on the same organisation. The d3SC output was then analysed and compared to the content analysis of a number of semi structured interviews with the organisation's management team.

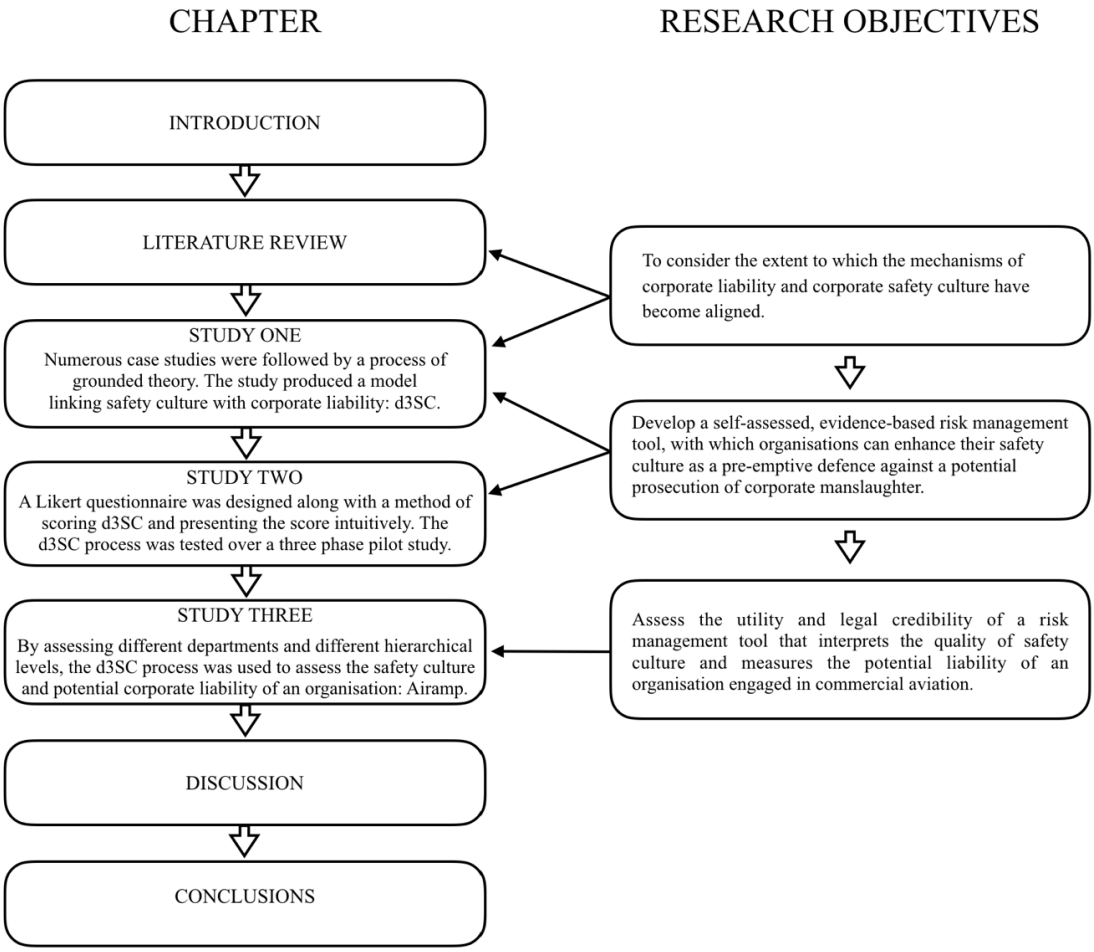

Figure 1 The structure and flow of the thesis.

1.7 Scope of the Research

This thesis compares elements from two very broad and complex philosophical subjects; culture and causation. These subjects and their associated theories attract considerably more literature and debate than could be addressed within the practical constraints of a doctoral thesis. As such, the predominant focus of the thesis is on safety culture and legal causation; the thesis attempts to deal with each area to an appropriate level with which to outline the landscape of relevant debate. Although there are references to numerous jurisdictions and international law, the thesis predominantly focusses on the legal mechanisms of the United Kingdom. The research question is influenced by relatively recent developments in corporate liability and in particular the phenomena of corporate criminalisation within commercial aviation. Although there are references to military accidents the focus is on commercial accidents and only those reports and legal cases since 2008.

1.8 Original Contribution to Knowledge

The study will contribute to knowledge in the areas of safety, risk and law in the following areas:

I. Develop a theoretical link between evolving concepts of legal causation to evolving theories of safety culture.
II. The development of practical risk management tool which promotes the corporate benefits of resilient safety culture.

A model which accurately encapsulated the dynamics of an organisation's safety culture against a legal benchmark could provide a further component tool in the development of corporate governance and risk management programmes. The concept of this study was inspired by techniques of managing uncertainty in risk management. In risk management, a commonly used tool with which to assess relative levels of risk is the risk matrix or 'heat map', (David & Wilkinson, 2009). These matrices can be used to evaluate the relative acceptability of risk and aide decision-making. They use colour coded elements to provide the user with an intuitive grasp of the relative levels of risk exposure. They also provide a common nomenclature of relative risk which aid the building of benchmarks of acceptable levels of risk exposure.

Drawing on similarities to the generic concept of risk, the complex relationship between the various attributes of safety culture and those of corporate law combine to prevent any manageable level of certainty with which organisations can develop corporate policies and procedures. The output of this study is a tool which provides a visual representation this complex relationship which can be intuitively read by non-specialists and used to manage programmes of continual improvement. The incentive for an organisation is that the use of such a tool could provide the basis of a defence of due diligence. Due diligence is effectively the antithesis of fault. It is a specified defence in some jurisdictions such as the UK. The legal strategy is promoted by Gobert & Punch (2003) and Pinto & Evans (2008).

These writers describe due diligence as not only an effective approach to corporate risk management but in highlighting the potential protection from corporate criminal charges, a legal system can promote best practices within any industry and raise standards of

commercial operation. Whilst the majority of programmes which aim to use safety culture in commercial aviation to improve safety performance have adopted the regulatory route, this study will assess a broader array of legal mechanisms with which to develop a legal standard of safety culture. Before development of the tool could commence, an understanding of the discourse within this research field was required and is described in the next chapter.

2 LITERATURE REVIEW

2.1 Chapter Introduction

In assessing the literature, the review focuses on the primary areas of theory which sit within three main groupings; that of safety science, risk management and corporate liability. As the review spans different but interrelating disciplines it is not intended to cover all elements of each main subject but to give context to each subject's relevance to the central issue: how safety culture could evolve as a legal standard.

The initial part of the literature review aims to give the reader an overview of how commercial aviation quantifies safety performance and particularly how safety culture is increasingly seen as a mechanism to improve an already high performing or 'ultra-safe' system. Despite achieving remarkable levels of safety performance, the nature of this complex system is changing. Traditional retrospective methods of measuring safety performance have less relevance in this increasingly complex system. Methodologies which assess the nature of the total system by measuring its emergent attributes rather than de-constructive approaches to individual accidents are needed. The literature review considers how safety culture assessment could contribute to these developments in safety science and risk management.

To provide some context to the construct of safety culture, the theoretical background to organisational culture is explored. As the two constructs are inextricably linked, the influence and phase of organisational culture theory is described. The initial debates between functionalist and ethnographic perspectives would seem to have been superseded by questions of how cultural characteristics influence organisational effectiveness.

The rise in prominence of safety culture is discussed by considering why the imposition of regulatory standards produces a considerable dilemma for policy makers. With similarities to the broader debates concerning organisational culture, the importance of contextual understanding of cultural characteristics is necessary. Successive efforts to benchmark and provide consistency to safety culture assessment have been unsuccessful and arguably counter-productive. New approaches to measuring and promoting safety culture are required and the significance of establishing a legal standard of safety culture is emphasised.

Although there has been some progression towards regulatory intervention, legal liability revolves around the central concept of causation. The finesse of philosophical reasoning has had to adapt to the practicalities of jurisprudence; issues of legal causation are considered in light of evolving concepts of the moral agency of corporations[4] and their influence on social safety concerns. The possibility of the emergence of a legal doctrine of organisational culture is also considered and the basic concepts of the relationship between accident causation and accident liability are explored.

Despite some of the complexities surrounding causation and corporate liability, there is a sufficient association between organisational safety culture and safety performance to impute liability. One symptom of this link is manifest in the global rise in the criminalisation of aviation accidents. It is also reflected in a broader global trend towards enacting mechanisms of corporate manslaughter. Whilst recognising a distinct trend in the jurisdictions of neo-liberal free market economies, the primary focus of the review is on the establishment and potential impact of the UKs Corporate Manslaughter and Corporate Homicide Act 2007.

[4] This thesis interchangeably uses the terms of organisation and corporation. For the sake of brevity, it should be interpreted to include all manner of business entities regardless of their incorporated status. This would include partnerships, limited liability companies, universities and other similar business entities.

2.2 Measuring Safety in Commercial Aviation

At face value, commercial aviation has achieved a remarkable level of safety (Stoop & Kahan, 2017). In a study of global commercial aviation statistics between 2000-2007, Professor Arnold Barnett of the Massachusetts Institute of Technology, concluded that in most developed countries, the odds of being killed in an aviation accident were one in 14 million. In effect, a passenger would have to fly every day for over 38,000 years before succumbing to a fatal accident, (Barnett, 2010). Well publicised statistics annually promote this statistical high performance. According to an annual analysis published by ICAO (International Civil Aviation Organisation)[5], the industry enjoyed its safest year on record in 2015; of the approximately 40 million global commercial flights, there were only 92 accidents, resulting in an accident rate of 2.8 accidents per million flights. "The year-over-year accident statistics indicate a decrease in the overall number of accidents as well as the accident rate", (ICAO, 2016:5). ICAO is charged with providing regulatory guidelines of safety management for commercial aviation, now in the third edition of its Safety Management Manual (SMM), it describes safety as "the state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management", (ICAO, 2013:2-1). This traditional approach to safety management is probably best summed up by Reason (2000:3), who stated that, "safety is defined and measured more by its absence than its presence."

Analysis of the ICAO definition highlights two significant features of the ICAO perspective of safety management. The first is that it that safety can be measured, and by implication, managed through the development of predictive models. Secondly, that it has something to with 'possibility of harm' or risk and suggests it can continue to be managed to tolerable level. In the first part of this paper, contemporary safety management metrics will be critically assessed as a suitable mechanism for predicting system safety. The second section will discuss the debate surrounding accident theory and causal models. The third section of this paper will consider the origins and influence of safety culture.

[5] Based in Montreal, Canada, the International Civil Aviation Organisation, a division of the United Nations sets and maintains common standards and best practice procedures for global commercial aviation.

Evolving theories on safety have increasingly focussed upon an understanding of organisational behaviour and particularly the cultural landscape which influences safety within organisations, (Guldenmund, 2000; Glendon, 2008; Leveson, 2004, 2009). According to Reiman & Oedewald (2007), the most important question is how safety culture can be usefully engaged to promote continual improvement in the safety performance of complex systems.

2.2.1 Safety Risk Management

From a functional perspective, 'risk management' tends to refer to a systematic process to evaluate risks and the subsequent implementation of safety precautions, (Steel, 2004). Perhaps because established methodologies of risk management have evolved from the financial and legal sectors they have been predominantly statistical and rule based. Within the aviation industry much of the literature on safety performance has emerged from engineering and technology disciplines, (Stolzer, Halford & Goglia, 2011; Rodrigues & Cusick, 2012). Accident and fatality statistics are the primary medium for describing safety performance, (ICAO 2016; IATA, 2017; Boeing 2016; EASA; 2016). Described by ICAO as '…a key safety indicator for commercial aviation operations worldwide…', (ICAO, 2016:10). Accidents are defined by ICAO as either the loss or significant damage of an aircraft or an event which results in the death or injury of those on-board. Within ICAO's SMM three broad safety management approaches are promoted and classified as reactive, pro-active and predictive. However, in line with Reason's (2000) statement that safety performance data is most commonly described by the former, that is in terms of the number of accidents per number of aircraft movements (ICAO, 2016).

2.2.2 Measuring Uncertainty

From an actuarial science perspective, commercial aviation has been described as an ultra-safe system with accident rates that have fallen to between one accident per 10−5 events to one accident per 10−6 events, (Amalberti, 2001). The resultant paradox, described by Amalberti is that the current performance of the system denies the application of the traditional leading indicators of accidents or incidents. As commercial aviation accidents have become increasingly rare events they provide little to no broad sampling data and therefore considerable uncertainty over emergent patterns or leading indicators. The measurement of accident numbers can therefore provide the illusion of

control. That illusion is necessary for the purposes of mitigating social anxieties and maintaining public confidence, but not the perceived level of predictive accuracy that safety institutions might infer (Lofquist, 2010; Hollnagel, 2014, Townsend, 2016).

In the light of successive high-profile disasters, the concept of uncertainty has grown in significance within the field of social risk management (Royal Society, 1992). Public unrest in the aftermath of incidents such as commercial aircraft accidents stimulate questions about the validity of established risk management techniques. Hubbard (2009), identifies significant misconceptions in contemporary risk management particularly in the application of quantitative risk modelling and organisationally influenced inhibitors of effective risk management. In his explanation of the misuse of statistical risk management Hubbard (2009) refers to the work of the influential early 20th century economist, Frank Knight. Knight differentiated between the two concepts of uncertainty and risk. According to his definition risk is measurable uncertainty whereas unmeasurable uncertainty is simply that, 'uncertainty'. In effect, if we do not have a clear description or specification of a system, or if we do not know what goes on 'inside' it then it is clearly impossible to control it effectively; Hubbard concludes that we cannot carry out a risk assessment on a system we do not understand.

2.2.3 Unknown Unknowns

These phenomena described by Knight are sometimes referred to as 'known unknowns' or 'unknown unknowns'[6]. The latter suggest a broad discomfort in addressing the inability to understand and by implication how to control our environment. It has prompted calls for innovative methods to comprehend the mechanisms of complex socio-technical systems (Reiman & Oedewald, 2007). In his high-profile book, Talib, (2010), describes unforeseen high impact events such as nuclear reactor meltdowns, major financial instability or some major commercial aviation accidents, as 'Black Swans'[7]. Talib focusses much of his theory around the global financial instability of 2008. He quite rightly points to inadequate attention given to 'fat tails' in probability distribution and the

[6] The concept was originally proposed by Luft, & Ingham, H. (1961) in '*The Johari Window'*. The phrase was made famous more recently by Donald Rumsfeld the United States Secretary of State for Defense in 2002, during a Pentagon security briefing.
[7] The significance of Talib's book perhaps lays not in the originality or accuracy of the concept of Black Swan, but in the high levels of interest it generated from a society increasingly suspicious of actuarial predictions.

over use of Gaussian modelling. According to Talib, these events are rare to the point of defying conventional methods of prediction and therefore live outside of Knight's description of measurable uncertainty, or risk. Their profile and rarity combine to provide a high psychological impact on society. Black swan events would suggest that we cannot satisfy our evolving desires to control and develop coping mechanisms to predict or control the future by one conventional and traditional forms of risk management methodology, (Aven, 2013).

The definition of what truly constitutes a 'black swan' has been extensively debated, (Cox, 2012; Paté-Cornell, 2012; Aven, 2013). Aven makes the point that despite Talib's work being justifiably criticised for its lack of scientific rigour, his contribution in raising the profile of the changing nature of contemporary risk management processes justifies further academic debate on the subject. Paté-Cornell, differentiates between aleatory which is uncertainty through randomness of known but rare phenomena and epistemic which is uncertainty due to a lack of fundamental knowledge about the nature of complex or emergent risks within a system. She categorises Talib's 'black swan' events firmly in the latter category. Failures involving human error are rarely aleatory. Paté-Cornell refers to the example of the Deepwater Horizon oil rig explosion[8] which although it was preceded by near miss lead indicators they were ignored by the operator, regulator and the courts until a major accident actually happened. What these researchers collectively suggest is that accurate statistical prediction is neither possible nor necessary to manage and mitigate increasingly complex risks; a preferable strategy is to enhance our understanding of the systems and the motivation of the individuals within them.

2.2.4 The Weakest Link

From the broader field of socio-legal policy, Steel (2004) also implores us not to take an overly dependent stance on statistically derived data. She asserts that the assumption that we can discharge our responsibilities by the application of established risk assessment procedure is fundamentally flawed[9]. These methods of statistically derived safety policy,

[8] In 2010, the Deepwater Horizon oil rig exploded in the Gulf of Mexico killing eleven workers. The subsequent investigations revealed a pattern of rule breaking and inappropriate risk taking by the operational management team and crew.

[9] An approach endorsed by the Turnbull Guidance (Revised Turnbull Guidance on Internal Control 2005), itself endorsed by the London Stock Exchange, it requires senior directors to be responsible for managing risk and requires companies to have robust

infer a relationship between reporting behaviour and the occurrence major accidents. The underlying principle is predicated on the recording of relatively common events (and deriving predictions about the rare phenomena of major accidents), originally based on Heinrich's accident pyramid model[10]. Nascimento, Majumdar, & Ochieng (2013) found that linking or modelling the relationship between high frequency low impact events to low frequency high impact events holds little validity as a predictive tool in such a complex and low sample subject matter. Barnett & Wang (2000) not only highlighted weaknesses in the utility of statistical data such as the number of fatal accidents per sector or flying hours but also showed a lack of correlation when attempting to use such data as a predictive tool. Manuele, (2011) even speculated the original material used in Heinrich's work was fabricated.

More sophisticated safety management models have developed to attempt to address the issues that have arisen from traditional approach to monitoring and managing aviation safety (Hubbard, 2009). More recent analysis techniques have increased emphasis on predictive techniques; identifying risk types, modelling exposure and consequences then re-prioritising risks, (GAO, 2012). Fenton & Neil, (2012) and Paté-Cornell (2012), both promote the use of Bayesian paradigms and techniques. Cox (2012), describes how ten different techniques with which complex systems with highly uncertain outputs can be managed. Some of these models have been adapted from other industries and military applications, inter alia Fault Tree Analysis, Event Tree Analysis, Bow-Tie and Bayesian Belief Networks, (Netjasov Fedja & Janic, 2008). Netjasov et al, found all these processes to have limited prediction capability and were best used by describing elements or characteristics of accidents rather than providing explanations of cause. Oster, Strong and Zorn (2013), recommend more sophisticated methods of data collection with which to improve the identification of leading indicators or predictors of accidents.

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systems of internal control, covering not just "narrow" financial risks but also risks relating to the environment, business reputation and health and safety.

[10] Industrial Accident Prevention, H W Heinrich (1931), based on industrial accident reports of early twentieth century industrial accidents, found that one fatal accident was associated with 29 minor injury incidents and 300 no injury incidents. Often attributed to Heinrich is later work carried out by Frank E. Bird, of the Insurance Company of North America. Bird's extensive research produced a ratio of typically 600 reported incidents to approximately 30 significant incidents, 10 'near misses' and ultimately 1 fatal accident; often referred to as the accident triangle or iceberg model.

2.2.5 A Numbers Game

The dilemma safety managers are left with is that although retrospective assessment is a questionable scientific methodology, and has limits to its predictive capability, it nonetheless makes considerable practical sense, (Hollnagel, 2014). The first advantage is that the 'principles' upon which they are based are simple and intuitive; they seem practical and make sense to the non-specialist. Hollnagel states that these practicalities are based on the human need to feel safe from danger, without which we would be constantly pre-occupied with concerns rather than the task in hand. This justification through pragmatism is reflected by the United Kingdom's Health and Safety Executive. Referring to the use of extensive statistical mechanisms to demonstrate safety performance, they comment that these should complement natural and intuitive risk assessment as humans have developed their own in-built processes, "…mechanisms that reflect our personal preferences and the values of the society in which we live", HSE (2001:10).

Amalberti (2001), identifies a division between expert interpretation of risk and the interpretation made by the public. He concludes that the statistical mechanisms frequently used by safety institutions serve political rather than scientific purpose. This position is echoed from regulatory perspective by the former general of the United States Department of Transportation (DOT), "When a plane goes down in flames and dozens or hundreds of lives are lost, what the public want is reassurance - reassurance that the accident was a fluke, that flying is statistically the safest way to travel and that someone is watching over aviation to guarantee it is safe", (Schavio, 1997:238). Commercial aviation has achieved a status as an ultra-safe system and is considered the safest of contemporary modes of transport, (Savage, 2013; Stoop & Kahan, 2017). However, it's very success has deprived it of traditional, statistically derived leading indicators, leaving epistemic uncertainty about the system. Amalberti (2001), highlighted that the ongoing process of collating larger and larger accident data bases do not improve safety prediction. He claims that the processes have started to move away from their original intended purpose of simply monitoring accident rates rather than to continually linking accidents to incidents and then minor incidents. Over-dependence on quantified risk assessment has been observed by researchers and institutions across the aviation industry, "The quantification of risk is unfortunately sometimes seen as a 'numbers game', relying on

questionable data, crude modelling of scenarios and subsequent simplistic mathematical treatment", FAA/Euro control (2007:13).

2.2.6 Aircraft Accident Investigation

The broader political and social influences on the way safety performance is presented also extends to accident investigations and how they are reported. Annex 13 to the Chicago Convention provides guidance on recommended practice in air accident investigation (ICAO, 2016). Now in its 11th edition, it provides new guidance on how co-ordination is maintained between accident investigators and judicial authorities. Further guidance on the conduct of aircraft accident investigation is contained in ICAO Doc 9756 (2nd Edition), 'Manual of Aircraft Accident and Incident Investigation', (ICAO, 2015). Both documents state that the sole purpose of accident investigation is the prevention of further accidents, whilst the purpose of judicial process attempts to establish attributable causation; differences described as 'irreconcilable' by Lawson, (2015).

The significant difference in approaches between investigators and the judiciary is highlighted by the Australian Transport Safety Bureau (ATSB): "Various parties may become more focussed on interpreting and responding to an ATSB investigation report in the context of such legal proceedings about the occurrence rather than interpreting it as a basis for enhancing safety and providing learning opportunities for the future", (ATSB, 2008:87). The ATSB emphasise the learning opportunity of aircraft accident investigation and reporting and how the public attention should be exploited for the furtherance of safety best practice.

Dekker (2011) & Hopkins (2014a) both point out that safety investigations should not become overly focused on the particular causal explanations of the circumstances of individual accidents. As each accident has its own particular set of causally related circumstances it is not always appropriate when these circumstances are interpreted out of context into broader safety messages. Like the ATSB, they also suggest that the high level of public interest generated by an accident investigation is often an ideal opportunity to promote better and more appropriate safety and risk management practices in order to enhance overall system safety performance.

2.2.7 Modelling Accidents

Early accident causation models such as those promoted by Heinrich in his 1931 book, Industrial Accident Prevention, relied heavily on normative interpretations of linear causation. Undoubtedly the most famous example of this type of accident model being James Reason's 'Swiss Cheese Model', (Reason, 1990; 1997). The concept describes successive system barriers which act to prevent successive adverse outcomes. The model has featured in successive ICAO safety management documents (ICAO, 2013) and Health and Safety management guides (HSE, 2002). Fault tree analysis type modelling has had widespread use across numerous industries and is used to deconstruct complex systems into cognitively manageable forms. Ruijters & Stoelinga (2015), carried out a meta study of 150 papers of fault tree modelling; the objectivity of these models has been questioned as they invariably rely on the arbitrary selection of a 'root-cause' or initiating event such as a component failure or a human error (Hollnagel, 2004). One widely used example, adapted to human performance is Shappell & Wiegmann (2001), who based their Human Factors Accident Classification System (HFACS) on Reason's model. More elaborate versions of these types of models such as Tripod Beta and Delta[11] and Accimap (Rasmussen, 1997; Hudson, Reason, Bentley, & Primrose, 1994), have seen extensive application across the nuclear, petro-chemical and commercial aviation industries. These types of causation models have attracted criticism for their lack of utility within the complex systems in which they have been extensively applied. That criticism has particularly focussed on the arbitrary selection of significant human error events above other less obvious causal factors in constructing explanatory models of organisational failure (Helmreich & Merritt, 1998; Leveson, 2004, 2011; Hollnagel, 2014; Dekker, 2016).

In an implied rejection of intuitive or linear causation, more recent accident causation models have reflected the complex and inter-dependent nature of organisational accidents. There are two main approaches that have dominated recent theoretical discussion on safety management. Normal Accident Theory (NAT) and High Reliability

[11] Tripod Beta and DELTA were developed by Shell International Exploration from safety research funding programs in the 1980s. The former maps linear accident causation while the latter uses similar principles to attempt to predict future events, (see Hudson *et al*, 1994).

Theory (HRT), (Leveson et al. 2009; Shrivastava et al. 2009a; Dekker 2005, 2011a). NAT is originally based on the 1978 book by Barry Turner: 'Man Made Accidents'. NAT was further developed by Charles Perrow in his study of the Three Mile Island nuclear disaster in 1979. The causal theory describes how technological systems have a tendency to become complexly interactive and 'tightly coupled'. The theory suggests that these systems can fail when they experience a combination of circumstances, but the overall driver of this state of vulnerability is the 'normal' characteristics of the system itself rather than some unforeseen external influence (Perrow, 1999). The tight coupling of complex and interdependent components is driven by an ongoing pursuit of productivity efficiency that is then transferred to the collapse of the system itself.

In contrast to the holistic view of system safety adopted by NAT, HRT concentrates on the individual threats to system safety and focuses on the ability of high-risk operations to compensate, manage and evolve to their threat environment. Predominantly based on work by a group of Berkeley scholars including inter alia, Roberts & Rousseau (1989), LaPorte & Consolini (1991) and Bierly & Spender (1995) the theory evolved from observations of highly reliable organisations (HROs) and their activities such as United States Navy operations, the nuclear power industry and ATC. Although the results seem to describe something of a 'Holy Grail' of safety practitioners, (Weick & Sutcliff, 2001), the observers to these highly skilled and highly motivated activities were at pains to point out the incredible amount of effort that it took to maintain these barriers and to achieve such a high level of resilience to disaster.

Weick, Sutcliffe & Obstfeld (1999), emphasised the importance of cognitive effort, or mindfulness, in maintaining such a high level of resilience, the level of appropriate focus and commitment being another way of describing an organisation's level of safety culture at the operational level. As Leveson et al (2009:242) note, "All behavior [sic] is influenced and at least partially 'controlled' by the social and organizational context in which the behavior [sic] occurs. Engineering this context can be an effective way of creating and changing a safety culture." Although there is a significant shift towards system thinking in safety management, (Leveson, 2009), the safety models of NAT and HRT have been criticised for providing little else than high-level descriptions of systems behaviour rather than explanations of how events interrelated and converged into

accidents, (Dekker, 2005; Hopkins, 2014). Whilst both provide a description of how system design and functionality (NAT) and how the effective distribution of cognitive resources (HRT) can influence system performance, they give little more than a perfunctory explanation of how these processes can be applied to improve safety performance.

2.2.8 Utilising Accident Causation Models

Hopkins (2014) assessed Perrow's application of NAT theory to the BP Deepwater Horizon oil spill. He notes that Perrow explains the causes of such accidents in terms of management negligence and organisational process error rather than the mechanisms of NAT's complex interaction and tight coupling. He concludes that NAT contributes nothing to the causal explanation of the BP accident nor any previous case studies. The NAT theory has been criticised for its lack of applicability, ambiguity and non-falsifiability (Shrivastava, Sonpar, & Pazzaglia, 2009) and has prompted calls for accident causation models with better application to real world scenarios (Dekker, 2005; Shrivastava et al 2009). Although Perrow's model lacks utility, it does allow conceptualisation of large scale highly complex causal processes. If more immediate causal explanation is required then other functional approaches and analytical techniques can be applied. One such example is found in Reader & O'Connor's (2014), interpretation of the Deepwater accident. The event was analysed using a human factors assessment framework. Rather than simply trying to dilute events into a high-level explanation, the immediate causal factors of the operating crew were analysed. The crew's situation awareness level concerning the stability of the well-head was identified as a significant causal factor, however the study falls short of a how and why organisational influences interrelated with the crew's perception.

HRT has faced similar criticism of its lack of potential for broad practical application. Bierly & Spender, (1995) used an assessment of the on-board culture of a nuclear submarine to provide some insight to the potential of HRT in high safety performance environments. They focussed on the high level of performance that organisations can achieve when collective mindfulness is focussed on the avoidance, management and mitigation of organisational failure. However, Dekker (2005) questions the broader applicability of the necessary levels of consistent human performance required to

maintain near error free performance. His argument considers the inability to replicate the level of process control and 'mindfulness' on-board a nuclear submarine which could not be replicated in most work environments. Hopkins (2014) questions the applicability of HRT given that it has proved impossible to identify a priori which organisations qualify for the esteemed label of High Reliability Organisation (HRO). He uses the example of NASA, declared by Roberts & Roussaeu (1989), as a HRO in 1989 but two years later, (Roberts, Bea & Bartles, 2001), declared it was not. NASA's Columbia Accident Investigation Board used the yardstick of a HRO and found that NASA fell short of the description of near-accident free performance in the wake of two high profile multi-fatality incidents, (CAIB, 2003).

The utility of NAT and HRO models has been questioned as they lack applicability to real world examples. Successive case studies can be neatly described in terms of HRT or NAT, but difficulties arise when we try to a priori identify these organisations. The generic issue with all-encompassing models is that they tend to be descriptive by their very nature. The descriptive qualities look highly accurate when fitted retrospectively to individual high-profile accidents and yet ambiguous when we attempt to recognise emergent characteristics in complex systems.

2.2.9 Systems Thinking

The component approach to safety performance has been challenged by a group of safety researchers who have taken a top-down or systems based approach alternatively referred to as Cognitive System Engineering (CSE) or Resilience Engineering[12]. "Safety is a system property, not a component property, and must be controlled at the system level rather than the component level", (Leveson et al 2009:235). An understanding of the influences of these differing and sometimes competing influences are increasingly important in the management of human behaviour within complex and interdependent systems. Orasanu & Conolly (1993), identified that organisational influence filters through to the operational decision-making process not only through the imposition of standard operating procedures, but through the cultural norms of the organisation.

[12] This group would include *inter alia*, Rasmussen (1997), Woods & Cook (2002), Hollnagel (2004), Leveson (2004) & Dekker (2005) noted at Leveson *et al* (2009:241) also Marais *et al* (2004). However, in Dekker's later work, 'Drift into Failure', he bases his ideas from NAT as much as he does from Cognitive Systems Engineering.

Abrahamsen, Asche, & Milazzo, (2013) determined that unless organisations exercise continual commitment to safety improvements, the incremental introduction of new safety standards can reduce overall system safety. Firstly, resources are invariably re-allocated from existing protections systems and defensive layers. Secondly by implying greater levels of system resilience, risk homeostasis increases employee risk appetites. According to Leveson (2014), an understanding of the dynamics of complex systems and their emergent properties (termed 'systems thinking') is an essential element of how we learn to influence and potentially start to predict the output and behaviour of human interaction and decision making within complex systems. The systems thinking approach to safety management has increasingly focussed on the behaviour of organisations and the influence of organisational culture.

2.3 The Influence of Culture

The Oxford English Dictionary describes culture as the 'attitudes and behaviour characteristic of a particular social group'. Cooper & Denner (1998), categorised numerous definitions of culture but established the most common revolved around the anthropological concept of 'attitudes and values'. In relating its influence on the safety performance of organisations, Reason (1997, 2000) also categorised the study of culture is one of 'attitudes and values'; it can be described as a 'construct', insofar as it is inferred from statements and behaviours of individuals related to group behaviour. Studies of culture typically involve surveys and assessments of prevalent attitudes and opinions to influence or manage improvements in workforce behaviours, (Guldenmund, 2007). Cultural influences can be described by their source; from national, organisational or a further sub-group, such as gender, occupation or regional and so forth, (Hofstede, 2001).

2.3.1 National Culture

The majority of research into the influence of national culture has its roots in anthropology, (Hofstede, 1984, 1991, 2001, 2017; Haukelid, 2008).). In his earlier work, Hofstede initially proposed four dimensions of national culture: Uncertainty Avoidance, Power-Distance, Individualism and Masculinity[13]. Utilising Hofstede's criteria,

[13] Later work, (Hofstede & Minkov, 2010) expanded this to five with Long Term versus Short Term Goal Orientation and then six (Hofstede, 2011), with Indulgence versus Restraint.

Braithwaite (2001), assessed the positive elements of Australian national culture with those of other nationalities as possible lead indicators to influencing safety performance. Soeters & Boer, (2000) identified a higher chance of accidents with national cultures which displayed high Uncertainty Avoidance (UA); a high UA culture would display a trait of avoidance of the anxiety caused by uncertain, risky and ambiguous situations. More recent work by Noort, Reader, Shorrock & Kirwan (2016), identified a significant relationship between national cultural characteristics and safety culture. They hypothesised that there is a correlation between high levels of UA and low safety performance. Their underlying theory was that high UA promoted behaviours that would countermand positive safety related behaviours, such as inter alia open reporting, operational flexibility and non-process-driven decision making.

Noort et al (2016), concluded that the implications for international benchmarking of safety performance would have to be weighted to give meaningful comparisons. However, the complexity of cultural influences, would suggest that simple weighting of national characteristics overlooks the multi-faceted influence of culture. For example, Schein (1996), while describing his model of organisational culture, also emphasises the powerful influences of occupational or functional cultural influences which transcended national boundaries. He describes the interwoven horizontal influences of managerial, engineering and operator cultures and their interrelationships within the vertical components of the organisational hierarchy. Basing their work on Hofstede's criteria, Li, Harris & Chen (2007), determined that countries with high Power-Distance (PD) characteristics, made different types of errors, from those with low PD cultures. Significantly, they noted the increased frequency of contributory errors instigated at the higher end of the organisation in contrast to those in lower PD cultures, such as Australia or the United States. Cultural influences can be multi-dimensional or trans-national; the strength and of influence is not necessarily reflected in the overt organisational structure or in its espoused values.

2.3.2 Organisational Culture

The initial concept of organisational culture seems to have been borrowed from the field of anthropology, (Choudhry, Fang & Mohamed, 2007). However, the functionalist influence of culture as a mechanism with which organisations can enhance effectiveness

received considerable academic attention through the 1960s and 1970s (Martin 2001). According to Hirsch & Levin (1999) organisational theory followed a life cycle as the initial excitement over the inferred organisational control inferred by positivist system models gives way to the complexity of real world analysis. Hirsch & Levin (1999) describe the theory of organisational as divided between the 'umbrella advocates' of positivist approaches producing overarching systems models of organisational culture and the 'validity police' of ethnographic studies which provide contextual analysis. Edwards, Davey & Armstrong (2013), similarly delineated two broad strata of approaches to the study of organisational theory; the anthropological and the normative. They opined that normative, pragmatic or functionalist researchers, whilst having identified numerous systems, structures, policies and procedures have struggled to show how they can be utilised to change safety outcomes in an organisation. Similarly, the anthropological or interpretative approach has yet to provide validation that underlying beliefs, attitudes and values can be directly attributed to accidents. The study of organisational culture and its relationship to safety has been described as fragmented and unsystematic, (Guldenmund, 2007; Choudhry et al, 2007; Nævestad, 2009).

Martin (2001) identified three main theoretical approaches to organisational culture. She terms them as integration, differentiation and fragmentation. Integration identifies the unified and consistent characteristics of organisational culture epitomised by neo-positivist approaches such as Dennison & Mishra (1995) and Cameron & Quinn (2011). Differentiation focusses on discord such as the contrast between senior management policy and operational practice; consensus lies within the organisation but within sub-cultures. Fragmentation sees consensus as merely transient as the norm of organisational culture lies in constant change and discord. Martin advocates that rather than take any singular perspective, a three-perspective approach could give the researcher a deeper understanding of organisational culture, embracing what she describes as 'discomforting complexity'.

According to Schein (2017) although there are complexities in defining the extent and nature of culture, corporate cultures, even in large trans-national corporations can be identified and described as macro-cultures. Describing the concept as an abstraction, Schein's more recent work has consistently upheld his original model of organisational

culture. The model consists of three basic tenets; observable artefacts, values and underlying assumptions. Observable artefacts are effectively the look and feel of an organisation. These can give an impression of how an organisation may function and what some of the key drivers are, but they can also provide misleading impressions. Values can be explored through various forms of surveys and assessments; they can give an explanation to the nature of more visible artefacts by placing them into some form of context. To understand the underlying assumptions, Schein recommends focussed questions and self-analysis by group members, designed to challenge what has evolved into unquestioned principles within an organisation. However, in a similar approach to Martin, he warns against the use of over simplified models of culture and recommends a deeper methodological approach adopted from anthropology. He suggests that the underlying assumptions of an organisation are the essence of its culture. They are a function of the collective learning process rather than output of the group and are often embedded into organisational psyche, often through previous significant or traumatic experiences.

The common theme promoted by these organisational theorists is that progression in this field can only be achieved by combining elements of neo-positivist and ethnographic approaches. The life cycle described by Hirsch & Levin (1999) ultimately resulted in the component elements of organisational models out living the models themselves. But rather than accepting an inevitable process of theoretical entropy, a more purposive embracing of differential epistemology would seem a logical progression. Martin's (2001) three perspective approach epitomises this multi-faceted solution whilst Schein (2017) seems to have concluded a similar compromise by re-enforcing the importance of complementing his three-tier model with ethnographic analysis.

2.3.3 Definitions of Safety Culture

The International Nuclear Safety Advisory Group defines safety culture as "that assembly of characteristics and attitudes in organizations [sic] and individuals, which establishes that, as an overriding priority, safety issues receive the attention warranted by their significance"[14]. The Confederation of British Industry (CBI, 1990) refers to safety culture

[14] "Safety Culture" – A report by the International Nuclear Safety Advisory Group (Safety Series No.75-INSAG-4).

as "…the way we do things around here". However, despite the various definitions, many accident investigation bodies such as the NTSB are reticent about describing 'safety culture' as a 'probable cause' of accidents. "Investigators should be particularly cautious about attempting to assess safety culture after an organization [sic] has experienced an accident or incident". Czech *et al* (2014:5), assert that the inability of safety academics and practitioners to provide a useable definition of what safety culture is, lies at the foundation of this unease with safety culture as an accident cause.

2.3.4 The Theoretical Context of Safety Culture

The weight of literature concerning the influence of culture on safety performance has been sociological studies of organisational culture. For example, safety culture has generally been described as a safety related component of the wider concept of organisational culture, Guldenmund (2000). According to Marais et al (2004:14), "[T]he safety culture is that part of organizational [sic] culture that reflects the general attitude and approaches to safety and risk management". Pidgeon (1998) marks the investigation into the explosion of the Chernobyl Nuclear Reactor in 1986 as the start of the development of this idea; the apparent 'poor safety culture' was identified by the investigating authorities[15] as a significant contributory factor to the accident. Having appeared in an official document the concept of safety culture had signalled its recognition within the field of accident investigation, (Glendon, 2008). Despite its rise to prominence in almost all safety management programmes and academic literature, a generally accepted definition has failed to materialise.

In a similar vein to organisational culture, Glendon & Stanton (2000), suggest safety culture theory is differentiated into two main approaches, the interpretative and the functionalist. Cooper (2000) categorised these and similarly broad definitions as a quality that an organisation 'is' rather than a quality it 'has'. The latter quality described by Cooper (2000:114) as a functionalist perspective, suggesting it can be manipulated to produce a safety output; the utilitarian potential of this definition favoured by managers and practitioners. An interpretative approach sees culture as a metaphor for the

[15] IAEA (1986). Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident, INSAG Series No. 1.

organisation, the culture is the organisation and its cultural traits define its essential nature, (Weick, 1995; Choudary et al, 2007, Edwards et al, 2013). The organisation has certain traits these determine organisational behaviours. Antonsen (2009) and Nævestad, (2009), both argue that conceptualisation of safety culture has failed to differentiate between the organisational culture, technology and managerial structures. In their opinion, safety culture is too often used as a metaphor for all three, rather than a specific sub-culture within an organisation.

This ambiguity of definition has not inhibited the rising profile of safety culture. It has evolved during a period where increasing attention has focused on a broader, systems-based approach to the management of complex systems. In many ways, the two paradigms complement each other, however the boundary between systems thinking and the assessment and management of an organisation's safety culture has become blurred. An intuitive link between the development of systems thinking and resilience engineering has developed with the growing popularity of safety culture as a concept. The validity of this link has been questioned by Reiman & Rollenhagen, (2013). They argue, that if systems theory attempts to encapsulate the whole rather than as a component of the system (as has been proposed by *inter alia* Leveson (2009)), then it conflicts with the concept of safety culture as a component or sub-culture of the organisation as a whole. However, this would seem to be a misunderstanding of the interrelationship of safety culture and systems thinking. Describing a system as a whole by virtue of its complex and highly integrated nature does not exclude the contextual assessment of cultural influences within that system. The analysis of safety culture does not have to be an exclusively system-wide approach to organisational analysis to complement systems thinking. An effective and utilitarian model of safety culture should aim to describe the influence and function of culture at multiple structural levels and at differing levels of intensity.

2.3.5 Safety Culture as a Descriptor

The causal significance of organisational factors in commercial aviation safety analysis found formal recognition through the dissenting comments of John Lauber of the NTSB[16]. Commenting on the loss of Continental Express Flight 2574 near Eagle Lake, Texas in 1991, Lauber stated that in his opinion the probable cause of the accident should read, "The failure of Continental Express management to establish a corporate culture which encouraged and enforced adherence to approved maintenance and quality assurance procedures" (NTSB 1992:54). Since its emergence as a concept, debate has continued, discussing how best to employ safety culture as a means of improving safety performance. Wiegmann et al. (2007) has noted that it is now recognised as such in a number of major accidents and analyses of systems failures including the King's Cross Underground fire in London and the Piper Alpha oil platform explosion in the North Sea.

The developing significance of safety culture is apparent in more recent accident investigations. The primary recommendation of Haddon-Cave (2009:576) of the loss of Nimrod XV230 in 2006 in Afghanistan was for the military to develop a 'New Safety Culture'. Following the loss of Air France 447, an Airbus A330 in 2009, one of the first reactions by the operator, Air France was to commission an independent review board to assess and report on its own safety culture[17]. Similarly, the Presidential report of the National Commission (2011) into the explosion of BP's Deepwater Horizon in 2010 made numerous references to the inconsistency and ultimate failure of the company's safety culture[18]. It is apparent that several investigative reports as well as numerous academic papers suggest that a dysfunctional, weak or absent safety culture is a significant feature in many serious accidents (Leveson, 2011). Safety culture has been used in some of the above-mentioned investigations as short hand for a whole plethora of organisational failings. Although it has achieved recognition in the interpretation of organisational

[16] The National Transportation Safety Board (NTSB) is an independent United States federal government agency charged with determining the probable cause of transportation accidents and promoting transportation safety and assisting victims of transportation accidents and their families.

[17] The Independent Safety Review Team (ISRT) was established in December 2009. It consisted of a number of global aviation safety experts and produced 35 recommendations for Air France. The document containing the recommendations has not been released to the public. Source: http://news.aviation-safety.net/2011/02/09/air-france-acts-on-independent-safety-review-team-recommendations. Accessed 1st July 2017.

[18] BPs own investigation report, Deepwater Horizon Accident Investigation Report, 8th September 2010, does not mention the term 'safety culture'. The report focuses on the technical and human failings of the BP and Transocean rig teams. The National Commissions report to the President mentions 'safety culture' 25 times.

failure, further investigation is required into the functionality of safety culture to improve its utility potential.

2.3.6 Culture or Climate?

In contrast to its broad acceptance as an underlying cause by accident investigators, the literature provides limited academic consensus as to a definition of safety culture. Guldenmund (2000) notes that while a general definition of safety culture can be appealing, it can also run the risk of being so 'global and abstract' as to become meaningless. Safety culture has been cited as a factor in numerous accident investigation reports and broader public enquires, the nature of the causal relationship has been somewhat conspicuous by its absence. The two concepts of safety culture and safety climate are associated with different definitions, research traditions and methods (Zohar, 2000; Clarke, 2000; Neal and Griffin, 2002). The safety climate tradition can be traced to the pioneering research by Zohar (1980) and the tradition has been much concerned with psychometric scaling research in order to identify generic safety climate dimensions (Guldenmund, 2007). Safety climate is often described as consisting of shared perceptions of safety related states of affairs (management commitment to safety, rule adherence, safety training, procedures, working conditions etc.), whereas safety culture is more associated with safety related values, assumptions and norms. This would suggest that the variables associated with safety climate, are more observable than those of culture. Lehmann, Haight & Michael (2009), studied the risk tolerance of mine workers over a two-year period. They concluded that risk tolerance levels showed no correlation to work based safety training but showed greater influence from the strength of company safety culture and in particular strong leadership and supervision. The outcome of this study might suggest that we cannot always draw too many assumptions about the nature of beliefs, attitudes and values (in this case associated with risk) from simple metrics of safety climate.

2.3.7 Measuring Culture or Climate?

Cooper (2000) considered that in the absence of a general concept of safety culture, assessing an organisation's safety climate has become a 'surrogate methodology' for the measurement of safety culture. Broad indicators of safety culture and climate have been proposed (Zohar, 1980, 2000, 2010; Edkins & Coakes 1998; Fleming 2001; Hudson

2001; von Thaden & Gibbons, 2008; Kim & Choi, 2016) but attempts to evaluate component attributes such as safety climate have proved inconclusive. Guldenmund, (2007) suggests questionnaires only reveal attitudes that exist across an organisation. According to Schein (1996) safety climate is envisaged as a collective psychological attitude to organisational safety, which preceded safety culture. The emphasis again that is placed on the collective rather than the actual nature of the culture can undermine the assessment of sub-cultural traits.

In an extensive review of safety culture literature, Gadd & Collins (2002) describe safety climate as a measure of attitude and safety culture as an indication of organisational priority given to matters of safety. Hudson (2001:10) holds the view that "the culture defines the setting within which the climate operates". Hudson's view suggests, like other commentators, that culture is the generic whilst climate is more focussed on the componential aspect of an organisation. Dennison (1996) describes the difference between organisational climate and culture as one of interpretation rather than different phenomena. However, Clarke (2006) and Guldenmund (2007) found the relationship between safety climate and positive safety behaviours as weak, questioning Hudson's perspective. Having analysed 23 studies within aviation O'Connor et al (2011) concluded that means other than safety climate, needed to be found in the measurement of safety performance. There seems to be little in the way of consensus as to where the boundary lies between climate and culture; the relationship should perhaps be viewed as complementary rather than competing perspectives on organisational values and attitudes, (Dennison 1996; Choudhry, Fang, & Mohamed, 2007).

After years of extensive research, Zohar (2010:1521), considers safety climate as a, "…robust leading indicator or predictor of safety outcomes". However, the issue may not be simply safety culture over climate but more to do with how these concepts are translated into metrics and in particular, singular indices. Morrow, Koves, & Barnes (2014) conducted an extensive assessment of safety culture across 97% of the nuclear power stations across the US. Their conclusions show considerable variation in safety culture metrics despite the highly regulated nature of the industry and the relatively homogenous nature of US society. They concluded that a critical aspect of safety culture surveys is the context in which the survey takes place. In effect, the survey is measuring

a perspective and the perspective of the assessment has to be considered as a significant variable. Despite showing high levels of consensus in the relative quality of safety culture, the researchers concluded that drawing a link from safety culture metrics to safety performance indicators was at best tenuous. They observed that despite producing different scoring levels, two separate areas might well demonstrate equal safety performance but have differing methods to achieve that outcome.

2.3.8 Models of Safety Culture

Models of safety culture have been predominantly descriptive rather than explanatory. Geller (1996) proposed a triad model of safety culture comprising of the environment, the person and behaviour. However, the descriptive model lacked an explanation of how the three elements interacted. Cooper, (2000), saw safety culture as a subset of organisational culture. Like Geller, he opines that based on theories of organisational culture, safety culture comprises of three interacting elements: psychological, behavioural and organisational. Cooper suggests, but does not quite adequately define, an outline mechanism of interaction based on Albert Bandura's model of reciprocal determinism. Bandura suggests that people's thoughts and actions are not wholly determined by their environment nor are they entirely self-determined. His model suggests that behaviour is a result of the two. Organisational models such as Burke-Litwin, (1992), Mintzberg (1995), Dennison & Mishra (1995) and Cameron & Quinn (2011) have been utilised to assess organisational effectiveness by breaking down organisational function into component parts.

In a similar fashion, Reason model provides a basic five component model of safety culture. The model describes positive cultural attributes described by Reason (1997), as *just*, so trust in the process allowed and encouraged open *reporting*, this in turn turned errors into *learning* opportunities rather than blaming individuals. An organisation's *flexibility* allows experts not managers to control difficult situations and effective communication developed an *informed* safety culture[19].

[19] The writer's italic emphasis: some of James Reason's (1997) characteristics of a positive safety culture: just, reporting, learning, flexible and informed.

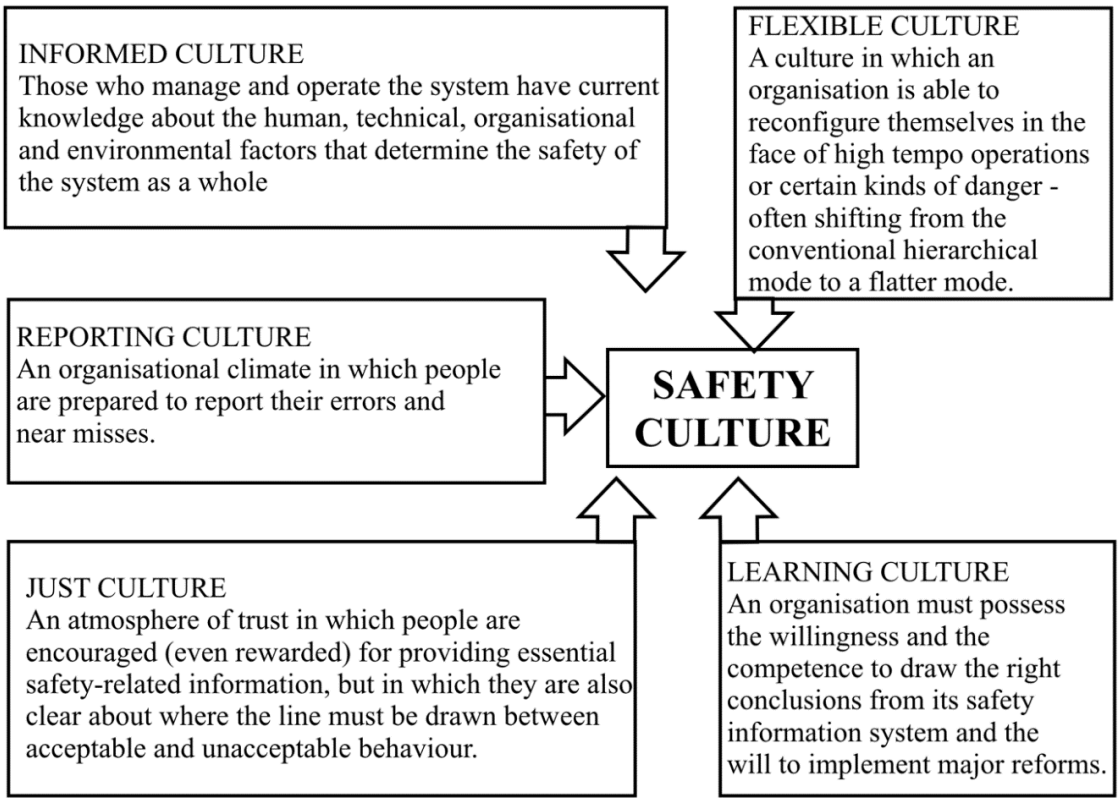

Figure 2 Adapted from Reason's (1997) Model of Safety Culture.

Westrum (1996), used the criterion of how organisations used safety information to determine their maturity over three scales; pathological, bureaucratic and generative. Fleming's (2001) Safety Culture maturity model, similarly based its assessment on an organisation's ability to learn and improve consistency around safety management. Developing Westrum's idea, Parker, Laurie and Hudson (2006), developed a model over five scales; pathological, reactive, calculative, pro-active and generative.

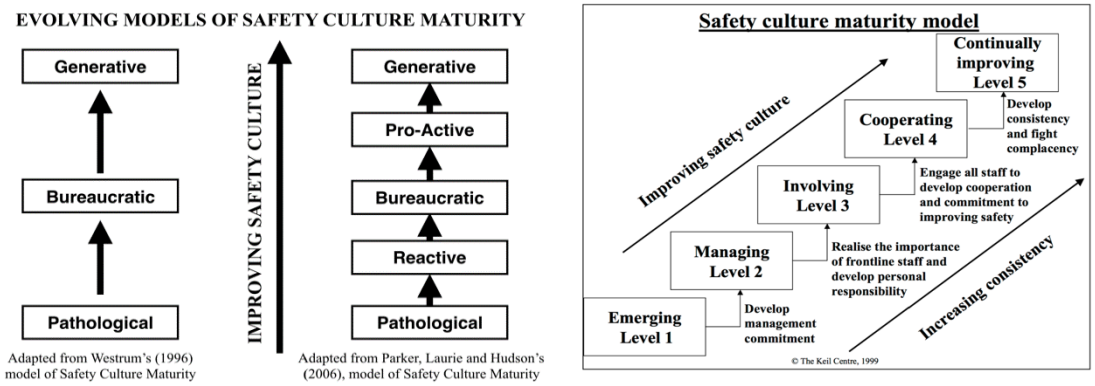

Figure 3, Examples of Linear Safety Culture Maturity Models from Westrum (1996), Parker et al (2006) & Fleming (1999).

They assessed an organisation over eighteen areas of safety management and scaled each to develop a comprehensive description of the organisation's safety culture.Uncertainty as to the exact nature of safety culture has undoubtedly inhibited the development of a broadly accepted model. Fang & Wu (2013), concluded that there is no way to develop a universal instrument to measure safety culture as cultures varied from industry to industry and district to district. They recommended that whilst some form of benchmarking tool would aid further research a preferable compromise was to contextualise the safety culture model to its specific industry.

As Choudary et al (2007), Antonsen (2009), Nævestad, (2009) and Edwards et al (2013) have highlighted, much of the literature describing safety culture consistently assumes to describe the whole when in fact it relates to dimensions, elements or a specific sub-culture of an organisation. Although challenged by Haukelid (2008), the consensus of opinion is that safety culture requires senior management commitment. For example, Flin, Mearns, O'Connor, & Bryden, (2000), and Flin (2007) identified perceived management commitment to safety as the most common characteristic of a positive safety culture. They assert the idea that influence trickles down an organisation. Hopkins (2006), suggested that for many writers, only organisations that demonstrate strong commitment from senior management can be said to have an authentic safety culture. Leveson (2009, 2011), also describes the level of senior management commitment to safety the highest common factor in determining higher or lower accident rates. Rather than attempting to encapsulate one singular definition of safety culture, more recent modelling of safety culture has attempted to incorporate aspects of contextualisation to the area or industry of study. There would also appear to be a general recognition that models of safety culture need to evolve to promote further utility and management of safety performance.

2.3.9 New Approaches to Safety Culture

The overall picture of the nature of safety management in commercial aviation is of a complex and politically motivated compromise rather than an evidence based and progressive system of improvement. If we accept the statistical data at face value, the safety performance of the whole commercial aviation system seems to improve, almost year on year. The system seems to embrace the mediocrity of acceptably low levels of attrition rates. Conventional safety management systems have evolved from less complex

systems than those of today and certainly those of an expansive and increasingly complex future. Without new methodologies, we will understand less and less about how complex systems function and safety management systems will progressively lose predictive capabilities. As many commentators have observed, safety science has been overly focussed on the rare (and almost unique) examples of when the system fails to function. Statistical descriptions of commercial aviation safety seem set on describing a successful system yet when analysed during accident investigations, frequent themes of organisational failure have emerged. The accident investigation processes have themselves been criticised for being overly descriptive rather than placing incidents within a systems context to allow broader analysis of systemic causes. Conceptualising and modelling safety culture has similarly produced a fractured and inconsistent picture of not only the nature of safety culture but how it might be usefully applied to the safety risk management of a complex system. Whilst high level system thinking descriptions of past events give an impression of deep understanding, they provide little in the way of predictive utility. However, the use of component analysis tools of cultural characteristics, within a systems-thinking paradigm, would not seem irreconcilable. There is a consistent message from critics of both accident investigation and case studies of organisational accidents as being overly descriptive. Retrospective identification of traits of poor safety culture should not be automatically re-applied to other organisations or even industries without reference to the context in which they influenced specific outcomes. New models, metrics and techniques of safety culture are needed to develop predictive safety systems that help us to monitor, manage and predict performance in complex and interactive systems. Aligning safety culture with corporate liability is potential way forward.

2.4 A Legal Standard of Safety Culture

A legal standard might broadly be defined as a standard of conduct which (in the context of corporate liability) is the norm for its industrial sector. A breach of this standard might include reducing costs by compromising regulatory compliance (Zhang, Bartol, Smith, Pfarrer, & Khanin, 2008). It may also include organisations which achieve regulatory minimum, but in the aftermath of a fatal accident are found to fall below the standards of reasonable expectation of society or the criminal justice system because of a tendency to

manage a spread, rather than manage a reduction of risk (Wells, 1996; Gobert & Punch, 2003; Hopkins, 2005; Pinto & Evans, 2008; Almond, 2013). In the face of global corporatisation, and a hardening of social attitudes towards corporate malfeasance, legal systems have adapted concepts of corporate fault to meet public expectation, (Slapper, 2010; Almond, 2013; Forlin & Smail, 2014; Hopkins, 2015). Set against the background of these changes in the international socio-legal landscape, this paper focuses on the emergence of a legal standard of safety culture within commercial aviation.

2.4.1 A Brief Note on Comparative Law

Before proceeding with this discussion, it is worth mentioning the differences between civil and common law systems[20]. These differences are not, however, always clear cut and many processes and underlying principles are common to all legal systems. Whatever differences there may be in their approach to justice, both attempt objectivity and most significantly, the philosophical foundations upon which they are based are long standing and supranational (David & Brierley, 1985). For example, adversarial and inquisitorial courtroom processes prevail within common law systems; of note are public inquiries and coroner's courts, where both systems run side by side, (Holland & Webb, 1991). However different these legal mechanisms may appear in their functionality, the shared theme in their purpose is that they both attempt to produce a consistent decision-making process, but must achieve that consistency within the confines of political and social acceptability, (Haack, 2004). Given the social sensitivity of western democratic nations, they have been the source of the more progressive principles in fields such as product liability, bribery and finance, (Forlin and Smail, 2014). The high level of international influence of these nations suggest that they are invariably the source and occasional lead indicators of broader globally accepted trends in legal process, (Pearson & Riley, 2015).

2.4.2 The Rising Regulatory Profile of Safety Culture

The established source of internationally recognised standards regarding safety management in commercial aviation is the ICAO Safety Management Manual (ICAO,

[20] Originating in England the '*common law*', system developed during the reign of Henry II and was exported throughout the British Empire into the colonies in North America, Africa and Australasia. In Europe, '*civil law'* systems originated from the principles of the written Roman decree and evolved into the Napoleonic Codes (1804-1811) in the French civil law system; the German Civil Code (1896) in Germany. Civil law systems in Europe and Asia have generally styled themselves on either the French or German model.

2013). Now into its third edition, the document describes three eras of safety management based on contemporary knowledge; from the early 1900s to the late 1960s - the technical era; from the early 1970s to the mid 1990s - the human factors era; and latterly, from the mid 1990s to the present day - the organisational era. Improvements in aviation safety performance attributed to the first two eras, technical and human factors, have seen an associated development of regulatory regimes, which specify minimum standards of compliance. The influence of organisational culture and policies on the effectiveness of safety and risk controls is acknowledged and defined within the opening pages of ICAO's SMM, "Culture is characterized [sic] by the beliefs, values, biases and their resultant behaviour that are shared among members of a society, group or organization [sic]", (ICAO, 2013:21). Within the sphere of formal accident investigation, safety culture first achieved formal recognition during the IAEA, (International Atomic Energy Agency), investigation into the explosion at the Chernobyl nuclear power plant, in Ukraine in 1986, (see Table 2-2). From an academic perspective, safety culture is generally recognised as a derived component of organisational culture, relating to an organisations safety and risk management practices, (Schein, 1996; Cooper, 1997, 2000; Guldenmund, 2000). In recognising the significant influence that organisational culture has on risk related behaviours, number of contemporary safety science commentators have implored operators and regulators to develop and improve organisational safety culture, in order to improve safety performance, (Cooper, 1997, 2000; Guldenmund, 2000; Hopkins, 2002; Bell & Healey, 2006; Morley & Harris, 2006; von Thaden & Gibbons, 2008; Leveson, 2011b).

2.4.3 Regulating Safety Culture in Commercial Aviation

Whilst its positive influence on organisational behaviours has been generally accepted, implementing a regulatory standard of safety culture presents a considerable challenge, (Reason, 1997). A number of regulatory programmes are developing; Table 2-1 describes three generic strategies to regulating safety culture at international, national and organisational level. Eurocontrol is the organisation responsible for Air Traffic Control Management Europe. Since 2012 it has introduced a safety culture assessment following Regulation EU390/2013; safety culture is identified as a key performance indicator. Similarly, the Swiss Federal Office of Civil Aviation (FOCA) and the United Kingdom's

(UK) Civil Aviation Authority (CAA) have embarked on the development of a safety culture assessment programme based on the work of Piers, Montagne & Balk (2009). In an effort to try to quantify the essential elements of safety culture and provide an acceptable regulatory definition of safety culture for these initiatives, six phenomenological indicators have been identified, based on the work of Piers et al: *management commitment* to safety, *safety behaviours*, *flow of safety related information*, organisational *adaptability*, employee *awareness* of safety issues and finally, *justness* i.e. how 'just' is the organisation's culture[21].

The only commercial aviation accident investigation body, we are aware of, which even approaches a formal post-accident assessment of safety culture attributes, is the Transport Safety Board (TSB) of Canada. TSB Canada, the country's multi-modal accident investigation body, have developed a common framework for its staff to investigate organisational and management factors. The stated aim of this TSB Canada policy is to address systemic issues that shape human performance, (Morley & Stuart, 2014).

2.4.4 Challenges to Regulating Safety Culture

A consistent criticism of many safety culture models is their predominant basis in Western cultural norms and value sets, (Hudson, 2007). However, recent research by Reader, Noort, Sharrock & Kirwan (2015), has utilised the national characteristics identified by Hofstede (2001), to adjust safety culture indicators to accommodate national characteristics. Reader et. al and subsequent work by Noort, Reader, Sharrock & Kirwan (2016), have made an important contribution by recognising significant differences in national attitudes to critical attributes of safety culture. In establishing a link between Hofstede's 'uncertainty avoidance' (UA) and 'power distance' (PD) indices, to significant safety values and beliefs, such as rule compliance, risk appetite, blame, adaptability and reporting behaviours, their work provides further insight to our understanding of the causal influence of safety culture. However, the establishment of a universal regulatory defined standard of safety culture has more fundamental obstacles to overcome. A number of academics have challenged the idea that safety culture can actually be measured and therefore managed or regulated in any conventional sense.

[21] The *italic* emphasis is added to illustrate the title of each assessed characteristic of safety culture.

Grote, (2007) suggests the utilisation of safety culture to achieve broad consensus across an organisation through 'loose coupling', is key to enabling organisational adaptability in the face of uncertain outcomes. Accordingly, Grote & Weichbrodt (2013), suggest that the 'abstract concept' of safety culture itself is an inappropriate regulatory objective and focus, should instead, be directed at rule adaptation and interpretation by the workforce by which the quality of safety culture can then be inferred. Le Coze & Wiig (2013), note that when a generic programme of improving health and safety culture was introduced to the Norwegian petroleum industry, variable interpretations from the regulator, management and the workforce resulted in significant disparities in the programme's output.

2.4.5 The Risk of Certainty

An intuitive response to academic and industry ambiguity concerning definitions of safety culture, might be to provide a regulatory definition and enforce through threat of sanction. Wahlstrom & Rollenhagen (2009), considered such a strategy of certainty. They concluded that in providing operators with an approved definition or standard by which they can compare their own safety culture with other industry operators, the regulator creates an achievable minimum acceptable level of safety culture. However, the self-determined achievement of this goal, would ultimately be counterproductive to long-term safety performance. Mishina, Dykes, Block & Pollock (2010), explored how illogical the collective action of corporations can be, driven by individuals pursuing their own short-term agendas. Simpson, Rorie, Alper & Schell-Busey, (2014), challenged the belief that deterrence is an effective regulatory strategy to influence corporate behaviour. Their meta-study suggested that regulatory strategies should not assume logical or proportionate responses by corporate actors. Organisations may similarly adopt the position that non-compliance, shrouded in the veil of 'equivalent' or 'alternative' means of compliance, will suffice.

Simple cost benefit analysis would lead in the direction of Fischel's argument that the "optimal level of violations of law…is not zero" (1982:1271). Fischel (1982) suggests that relatively small fines and penalties are simply an acceptable cost to corporations; a necessary cost of maintaining an optimum market strategy in the face of regulatory hurdles. Almond (2013), makes a similar point. He argues that as regulation is primarily

concerned with managing rather than prohibiting certain conduct, enforcement action is rare. The net effect is that regulatory policy provides limited threat of reputational or penalty loss. According to Faure (2014), the effect of deterrence is further curtailed through the extensive use by corporations of comprehensive insurance products which mitigate the risk of asset loss.

2.4.6 The Risk of Ambiguity

Hopkins (2014) considered the alternative perspective. He warns that an inadequate definition of safety culture could lead to investigators imputing operators' thoughts rather than focussing on what has actually been done. But whilst there are difficulties in constructing a definition of the concept of safety culture for regulatory purposes, avoiding the pursuit of a definition creates other issues. Ambiguity could encourage the promotion of 'corporately palatable' versions of the concept of safety culture, or politically convenient interpretations of accident causation, (Dempsey, 2010). Dekker & Leveson (2014) and Kringen (2014) both noted an association with systems approaches to safety management with the transference of accountability from individuals to the system, avoiding the thornier issue of responsibility. The concept of safety culture remains something of an inconveniently abstract term with which safety performance can be engineered towards improvement. In contrast, it is perhaps a little too convenient a quasi-legal term, used post hoc, to explain why organisations fail. As an example, Grote & Weichbrodt, (2013) refer to the BP Texas City accident, (see Table 2-2), which describes many organisational problems, but with little detailed analysis. The report concludes that inadequate safety culture was the major cause of the accident as a blanket assessment of a failed organisation. A similar criticism could be made of the findings of the public inquiry into the high mortality rates of patients under the care of the Mid-Staffordshire National Health Service Foundation Trust, in the United Kingdom, the failures of the Trust were loosely defined concept of culture; cultures of 'fear', 'bullying' and 'secrecy', Francis (2013:16). Francis avoided imputing individual liability on the governing board by explaining the failures under the broad definition of 'cultural' causes[22]. However, before we can assume that an organisation to be held accountable for corporate failure

[22] Also see the Japanese government's reluctance to utilise the criminal justice system in the aftermath of the Fukushima nuclear disaster, (Levi & Horlick-Jones, 2013).

resulting in fatalities, the question must be asked as to whether safety culture is recognised as a form of legal causation.

2.5 Culture and Causation

The law makes a primary appeal to legal agencies to comply with accepted standards of reasonable behaviour under the principles of tort and criminal law. Only when those standards of reasonable behaviour are perceived to have been breached and agencies are perceived to have caused damage or injury should retributive law intervene (Mackie, 1980). When safety critical industries such as commercial aviation do fail, the scale and psychological impact inevitably attract the attention of the legal system. This is perhaps exaggerated by the belief that these systems are almost invulnerable to error and uphold the highest standards of self-regulation. This belief is articulated in the case of *George v. Eagle Air Services Ltd*[23], by Lord Mance, "… [A]ircraft, even small aircraft, do not usually crash, and certainly should not do so. And, if they do, then, especially where the crash is on land as here, it is not unreasonable to suppose that their owner/operators will inform themselves of any unusual causes and not unreasonable to place on them the burden of producing an explanation which is at least consistent with absence of fault on their part". If a legal system wishes to pursue individual or corporate agencies for alleged injury or damage, then some form of causal link must be established.

2.5.1 Causation

According to Ducasse (1993), a cause must be understood and defined in terms of the environment of the subject, the change in the subject's environment and the resultant change in the nature of our subject. It is an intensely political concept. The question of what caused an event is the first place the human mind tries to establish order and meaning to the world; the cause ascribes political, moral and legal responsibility (Tucker, 1995). Any event can be associated with an infinite number of antecedents. Which are chosen, by whom and within what organisation, determines how the context of causation is explained and according to where responsibility is focussed, (Bell & Healey, 2006; Dekker, 2007).

[23] UKPC 21, [2009] 1 WLR 2133 at [13].

Attributing causation is the job of a lawyer. Hudson (2014) suggests that the 'lawyer's perspective', of hindsight bias, and linear description of cause, over-simplifies the increasing complex modelling required to explain organisational accidents within their social context. However, scientific explanation is not the lawyer's role. When considering legal liability following an accident, it is important to consider that accident causation is as much an issue of societal perception of culpability as it is an ex poste technical explanation of events. Accident causation and therefore any subsequent criminal liability is as much a function of presiding social opinions on the nature of causation rather than the vagaries and technicalities of legal mechanism. Hudson is entirely correct in his assertion that there is a very different perspective between lawyers and investigators. The professional obligation of a prosecuting or plaintiff lawyer was clearly stated by Robert Lawson QC in an address at the Royal Aeronautical Society in London, is to establish liability or blame in order to pursue criminal charges or to recover civil damages, (Lawson, 2015). Their professional obligation is to pursue that goal and adapt an interpretation of events in a way that best suits their client's interests.

2.5.2 Causal Minimalists

The bulk of academic debate concerning legal causation can be spilt into two main groups; causal minimalists and causal maximalists. Minimalists, such as Green (1962) and Calibresi (1970), predominantly base their argument on the economic function of law. In their opinions on the function of the criminal and tort systems, they look for resource efficiencies in the prevention of malfeasant action. Their ideas are embedded in Western neo-liberal traditions of individual responsibility coupled with the association with capitalist free-market principles, (Mackie, 1980; Epstein, 1987). Causal minimalists rely on the establishment of liability based on the maxim of sine qua non, or 'but for' the actions of the responsible party, would the adverse event have occurred. They regularly illustrate their perspective by reference to the judgement of the Federal Court Judge Learned Hand in *U.S. v Carroll Towing Company*[24] who referred to three elements of liability which must be considered before imputing a responsibility on a legal body to take adequate precaution. First is the probability of harm associated with the activity,

[24] (1947) 159 F. 2d 169.

secondly the likely gravity of harm and thirdly the burden of adequate precaution. Once responsibility is established and should an adverse event occur, depending on our perspective, we can easily establish several explanatory combinations of events with damages to be attributed to the risk owner.

2.5.3 Barnett v Chelsea & Kensington Hospital

Another illustrative case of causal minimalism comes under the English case of *Barnett v Chelsea & Kensington Hospital*[25] where a man had drunk tea containing arsenic. The man attended the defendant's hospital but believing the complaint was benign, had been sent home to consult his own local doctor and the man later died of arsenic poisoning. Medical evidence later revealed that the deceased would have not been treated in time to save his life even had the doctor accepted him for hospital treatment. As such the court refused to impose liability for the death on the alleged negligence of the doctor, as the death did not occur 'but for' the doctor's actions, (Holland & Webb, 1991). Highlighted by Ducasse (1993), the case raises significant questions of the court's social and ethical responsibilities in acceptable risk to life. Perhaps driven by the court's reluctance to pursue a doctor for reasons of economic efficiencies or the era's social acceptance of criminalising holistic professions, the case describes a legal system apparently driven by technicality rather than moral pursuit, (Calabresi & Bobbitt, 1978). There is no such dilemma for minimalists who see the role of causation satisfied in its efficient distribution of social costs rather than providing objectivity in the allocation of social responsibility.

As well as questioning the economic argument, Mackie (1980) challenged the assumption made by causal minimalists in their use of counterfactual argument. He asserts that any number of antecedents would explain 'legally' where responsibility rests in any given example, as they would not have occurred 'but for' any one of them. Hence what appears to be 'explanatory' causation can be manipulated towards 'attributive' causation. The simplicity of the 'but for' explanation relies very heavily on our normative sense of responsibility as well as our collective knowledge of the likely sequence of events. As an example, Reason's Swiss Cheese model of accident causation relies on this type of componential sequencing, (Reason, 1990). Described by Dekker & Nyce (2011), rather

[25] [1969] 1 QB 428.

disparagingly as conceptually 'regressive', Reason's model is intuitive and an excellent tool in introducing organisational influences, although it can be easily manipulated by an arbitrary selection of antecedents.

2.5.4 Causal Maximalists

Arguably, a closer alignment with contemporary safety culture theory stems from causal maximalists. They reject the arbitrary and somewhat blunt nature of reliance on the linear and componential *sine qua non*. Basing their argument on Aristotle's principle of corrective justice, they see causation itself as part of the legal process and therefore must demonstrate functional and ethical application rather than having a purely descriptive function. They assert that law should consider the broader view of justice rather than simple economic practicality. Their perspective on the inadequacy of causal minimalism is usefully described by the famous case of *Berry v. Borough of Sugar Notch*[26]. Here a speeding car is struck and damaged by a falling tree. The arbitrary and sometimes illogical nature of sine qua non comes into play insofar as the speed of the car is effectively the 'but for' defence argument rather than incontrovertible allocation of liability for the risk to traffic and pedestrians of unstable trees lining a road.

Further technical requirements by causal maximalists are that cause must be both necessary and sufficient, to be consider a legitimate cause, (Epstein, 1987). Maximalist's argue that to justify the attribution of liability for harm, the cause of harm must be necessary and sufficient to have achieved the adverse result. An antecedent may be necessary for an outcome to be achieved but not sufficient to ensure that outcome to transpire. Similarly, an event may be sufficient to produce an event but not necessary for the outcome. They argue that to impose responsibility for an outcome onto a legal body, then causation must be both sufficient and necessary.

2.5.5 Is Safety Culture a NESS?

Mackie (1980), promotes a general theory, based on Mill's concept of causation as multi-faceted and complex. He posits that in any given situation, a relevant condition can be identified as a necessary element of a set of jointly sufficient conditions (commonly

[26] 43 A. 240 (1899).

described as a NESS). Mackie describes causal links to events in a similar way to how investigations have explained safety culture, i.e. as instances upon which we impose generalisations on the way that similar events tend to unfold. According to Wiegmann, von Thaden & Gibbens, (2007), safety culture has become increasingly associated with organisational accidents as it has developed an intuitive causal association in safety science, risk management and law. If we adopt a functionalist perspective to the nature of safety culture, we could argue that elements of safety culture could be described as the necessary elements of a sufficient set of causal conditions rather than simply a homogenous description of an organisation's values and attitudes. From a legal causation perspective, identifying organisational attributes of safety culture are akin to identifying the jointly sufficient conditions of an organisational accident. If we consider whether safety culture is a sufficient cause of accidents, we could say any one of the 'poor' attributes is sufficient to cause an accident, for example breaking a safety critical rule. The rule breaking is not however a necessary cause of an accident as accidents can occur whether rules were adhered to or otherwise. What has been noted by Wiegmann et al, is that certain attributes of organisational behaviour have become associated with accidents and these fall under the collective description of safety culture. When an accident does occur, our *a priori* knowledge of these types of events encourages us to select a probable cause. We select that cause from a set of jointly sufficient conditions that in the particular circumstances of the accident, was a necessary element for the outcome. The homogenous nature of safety culture provides a generous choice of credible causal explanations.

2.5.6 Safety Culture as Legal Causation: Three Arguments

If regulatory approaches are deemed inappropriate to the imposition of a standard of safety culture then broader liability under tort and criminal law will inevitably adapt to invoke liability as a reaction to social fears, (Pinto & Evans, 2008; Almond & Colover, 2010; Almond, 2013). Three arguments are proposed on why safety culture could be described in causal terms, without a more prescriptive definition. The first of these is that causation itself has achieved no more consensus in academia than safety culture. Both concepts are ambiguous. The second is that from a legal perspective, accidents and their causes need to be understood in terms of the motive of the inquiry which may be purely investigative but may, if undertaken by criminal prosecutors, be attributive. It is this area

where the ambiguity surrounding the definition of safety culture could easily be manipulated to serve prosecutorial purposes and manipulate safety culture to a causal influence. The third argument is that there is some evidence of the emergence of a doctrine of organisational liability based on safety culture.

2.5.7 Conveniently Ambiguous

The first argument for safety culture as a notion of causation lies in the observation that cause in law has evolved away from a deterministic concept to one which has had to adapt to the fluid nature of complex systems. Although causation is the pivotal concept of all forms of legal liability and social responsibility, it has remained necessarily indeterminate in its function and definition (Mackie, 1980). Certain established norms within the legal mechanism may hold the descriptive appearance of complex principles but are in effect no more than by-products of countless iterations of case law; the balancing of individual examples of justice with social necessity. Jurisprudence has allowed this development and promoted its acceptance, (Hart & Honoré, 1985). In parallel to the evolution of fluid notions of causation, a broad-church perspective on the debate about the nature of safety culture and its effect on organisational performance would concede certain basic principles. For example, that an appropriate level of resource is allocated to the assessment and development of safety culture, especially in complex safety critical systems, as it is invariably a positive influence and potentially lead indicator of organisational safety performance.

However, Feinberg (1984) described the drivers of the necessary social policy aspects of criminal justice systems are more usefully explained in terms of ‘harmfulness’ and ‘wrongfulness’. Basing their work on the findings of Feinberg, Rosenmerkel (2001) and more recently, von Hirsch, (2014) have found public perception of culpability is invariably interpreted through the outcome of events or harmfulness. If we set aside the extremely rare examples of deliberate harm (e.g. terrorist acts and suicide), the intent to cause damage is generally absent from aviation accidents (it is contradictory to the concept of an accident). Prosecutors have instead tended to establish culpability for aviation accidents based upon the more malleable terminologies of culpability such as

recklessness[27] and negligence[28] thereby manoeuvring around issues of specific intent. The implications of this emphasis on the significance of harmfulness in determining criminal liability are therefore highly significant for commercial aviation and the massive socio-psychological impact of aviation accidents.

2.5.8 Adaptive Causation

The second argument revolves around motive of inquiry in legal discourse. The law gives considerable respect to the philosophical foundation and ethical grounding of law, however in its practical application, there are numerous examples of deviation from philosophy and ethics, (Calabresi, 1970; Hart & Honoré, 1985). The imposition of vicarious liability on employers or the pure functionality of strict liability are but two examples. The legal system cannot exist and function as if it stands independently from politics and economics but must satisfy, at least in appearance, its own rule set (Kelley, 1978). The imposition of legal responsibility rests on many competing social demands which can obscure the rationale of societal risk sharing, (Hart, 2004). In the definition section of Annex 13 of the Chicago Convention cause is described as "[A]ctions, omissions, events, conditions, or a combination thereof, which led to the accident or incident", (ICAO, 2016). In the hands of a professional lawyer, a list of causal elements such as this can easily be adapted to a concept such as safety culture, particularly the phrase '…a combination thereof'. As opposed to standards of scientific causation such as those of epidemiology, legal causation merely requires the establishment of an intuitive relationship that is understood by non-specialists.

An example of where a significant shift in conventional thinking about causation occurred in the case of *Fairchild v Glenhaven Funeral Services Ltd*[29]. In this case the courts considered the causal link between an employer's negligence in exposing their employees to the dangers from inhaling asbestos fibres. An associated condition, mesothelioma was

[27] Under UK law following the decision in *R v G and Another* [2003] UKHL 50, [2004] 1 A.C. 1034, an individual is reckless when in a "…. circumstance when he is aware of a risk that it exists or will exist" or when "…a result when he is aware of a risk that it will occur; and it is, in the circumstances *known to him*, unreasonable to take the risk".
[28] In many jurisdictions negligence is generally associated with conduct falling below that, which could be reasonably expected of an individual where that individual has a duty of care. Although generally giving rise to civil liability, specified circumstances such as Art. 137 of the UK's Air Navigation Order 2016 can potentially make anyone who 'recklessly or negligently' endangers an aircraft, criminally liable.
[29] [2002] UKHL 22

identified as being the cause of death in approximately 2500 cases per year in the United Kingdom until 2030, (HSE, 2017). The disease typically takes two to three decades to manifest symptoms, making the identification of the malfeasant employer practically impossible. The courts determined that an employer would be liable if it could be proved that their activities exposed those to whom it held a duty of care to asbestos, as this materially increased the risk of the individual developing cancer[30]. The courts felt that the application of traditional, minimalist application of the sine qua non principle was wholly inadequate to establish justice in this case[31]. The case was a landmark not only in the satisfaction of a large class of victims of the disease, but in the sense that the court had circumnavigated one of the fundamental principles of law to adapt to the complexities of the disease, work patterns of the victims and relative contribution of the defendant employees. The complex way that safety culture influences rather than directly determines an outcome could be described in a similar way. For safety culture to be described as the cause or (more likely) a significant contributory cause of an accident, it must achieve status as an accepted feature of accidents by society. In the analysis of major catastrophes described in *Tables 3-1 and 3-2*, the appearance of the concept of safety culture has been sufficiently prolific as to be seen as an intuitive or common-sense causal element of an accident.

2.5.9 A Legal Doctrine of Organisational Safety Culture

The third reason that safety culture may evolve into a form of accident causation is that safety commentators have increasingly questioned the relevance of traditional metrics in predicting the output of complex systems, (Amalberti, 2001; Lofquist, 2010, Townsend, 2013; Hollnagel, 2014). Whilst the precise nature of safety culture is debated, the concept could be considered as an academic or legal euphemism for the quality of organisational functionality. In the current environment, following a serious aviation accident, a prosecutor may look to the observable characteristics of an organisation that are associated with safety culture. These could include the shared values within the company of the quality of safety training, attitudes to rules and rule breaking, the adequacy of procedures, the quality of working conditions and the artefacts of managerial commitment

[30] *Ibid at note 29*.
[31] *Ibid at note 29*.

to safety. Although, these issues may not be the direct influencers on how safety critical policy decisions are made, they may be considered as lead indicators of aggregate safety performance. Crucially for the for the organisation under investigation, it is how this performance could be viewed in the aftermath of a fatal accident. Linking safety culture to causation could be a viable strategy to incentivise improved safety standards rather than facilitating corporate prosecution.

The link between legal causation and safety culture has been explicitly considered. In comparing various models of imputing corporate liability, Cavanagh, (2011) highlights Part 2.5 of the Australian Criminal Code and suggests safety culture is a surrogate form of mens rea. Senior management's obligation to monitor and understand its organisation's safety culture is seen as a constant responsibility. Hill (2003), suggests that with the imposition of an organisational model of liability, an enhancement of corporate governance is more likely. She comments, "It is possible that corporate criminal liability in Australia will be more effective than director's duties in achieving recognition of the principle that 'directors are ultimately accountable for the corporation's culture' with a corresponding obligation on directors to monitor diligently", (2003:40). The supposition is that in the event of fatal accident, the diligent monitoring of safety culture could provide a pre-emptive corporate defence whilst its absence could attract criminal liability.

2.6 Corporate Liability for Accidental Death

2.6.1 Corporate Manslaughter

The most obvious translation of legal liability from the failure of organisational safety culture lies within the realm of corporate manslaughter. A UK statute designed to address public concern over corporate accountability for workplace fatalities has been petitioned for since the 1960s. Slapper (2010) notes that since UK law permitted the prosecution of a corporation in the 1960s, approximately 40,000 deaths have occurred whilst engaged in commercial or industrial activity, but only 38 cases were brought to a successful prosecution of corporate manslaughter.

The introduction of the UK's Corporate Manslaughter and Corporate Homicide Act 2007 (CMCHA)[32] followed several high-profile accidents in the UK that tested judicial credibility and the public trust in corporate governance[33]. The pace of investigations prompted by the CMCHA now seems to be gathering some momentum to an average of approximately fifty cases per year[34].

Pinto & Evans (2008) describe the causal element of the CMCHA as an aggregate assessment of an organisation's performance. The offence is committed when death results from a 'gross breach' of standards of the way an organisation 'manages or organises' its business. The parallels to many broad definitions of safety culture are abundantly clear. However, a duty of care must be owed to the victim and a 'substantial' part of the organisations conduct must be influenced by senior management, Ministry of Justice (2008). The emphasis on the involvement of senior management has caused some controversy and is discussed at length in a government consultation paper, (Wells, 2010). However, there is broad academic consensus of senior management commitment to safety management being widely associated with the quality and effectiveness of an organisation's safety culture, (Flin, Mearns, O'Connor & Bryden, 2000; Flin, 2007; Leveson, 2009).

2.6.2 Legal Personality

As Gobert & Punch (2003) repeatedly emphasise, the fundamental problem that the legal system has had to face in pursuing corporations in the criminal field is that the criminal law system is designed to deal with individuals. The famous statement, attributed to Baron Thurlow[35], "Corporations have neither bodies to be punished, nor souls to be condemned; they therefore do as they like…". The statement illustrates the crucial problem with the law's relationship with corporate accountability. To establish criminal liability the

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[32] The sentence for the offence is not custodial but an unlimited fine: guidelines for the offence were originally recommended to lie between 2½% and 10% of annual. Sentencing Advisory Panel, Consultation on Sentencing for Corporate Manslaughter, 15 November 2007, para. 60, available at http://www.sentencing-guidelines.gov.uk/consultations/closed/index.html, accessed 7 September 2012. (Annual turnover is the total money coming into a company; in effect, it's income).

[33] The details of these incidents are well documented elsewhere but as for their impact on the enactment of the CMCHA, five are of particular significance; The sinking of The Herald of Free Enterprise 1987, The Clapham Rail Disaster 1988, The Lyme Bay Canoeing Tragedy 1993, The Transco Gas Explosion Larkhall 2003 and The Hatfield Rail Crash 2005.

[34] In a letter of reply to Elizabeth Thornberry MP, Dominic Grieve, writing on behalf of the Attorney Generals Office, stated that as of the 4th April 2012 approximately fifty cases were being investigated on behalf of the Crown Prosecution Office. The Ministry of Justice website indicates this is a typical annual number of cases.

[35] Lord Chancellor of Great Britain 1778-1792. The quote appears in John Poynder Literary Extracts (1844) vol. 1, p. 2.

prosecution must establish that beyond reasonable doubt the accused committed the actus reus (guilty act) and they possessed the requisite state of mind, mens rea (guilty mind). The application of these principles to the abstract concept of a corporation has been a consistent problem for legal practitioners and academics. This formulaic approach of criminal liability cannot be set aside but could be adapted to new ideas about the nature of corporate influence and mind set.

2.6.3 Severing the Anthropomorphic Link

Prior to the CMCHA, corporate liability doctrine under the law of the United Kingdom was based around the principle of gross negligence manslaughter (see *R v Adamako*[36]). The prosecution had to identify the controlling mind of the defendant company to establish guilt. The sheer size and complexity of the modern corporation practically guaranteed immunity for senior management and for the company itself, (Gobert & Punch, 2003; Pinto & Evans, 2008). The requisite involvement of senior management was dealt with in *Tesco v Natrass*[37] and has as it remains a specified element of the statute it has yet to be robustly debated within the context of the CMCHA. The issue of corporate criminal liability has been one of the most widely debated in English legal and political history despite the recognition of the corporation as a legal entity dating back to the sixteenth century[38]. According to Slapper (2010:181), "Various directors claimed to know only a fragment of the lethal danger that materialised. It was not permissible to incriminate the company by aggregating the fragmented faults of several directors". The legal issue now revolves around the nature and requisite elements of causation, particularly the recognition by the CMCHA of the aggregation of responsibility of the corporate body and its safety culture. According to Hart & Honoré (1985) jurisprudence has allowed the concept of causation to drift into an issue of public policy. This position is a function of jurisprudence as issues of social policy often override individual notions of justice. The area of social policy that the CMCHA focuses on is corporate malfeasance in the field of safety management. Gobert & Punch (2003) see the law's acceptance of aggregated corporate responsibility through the CMCH as finally severing the

[36] [*1994*] 3 WLR 288.
[37] [1972] AC 153.
[38] In 1599, The East India Company was the first corporation to be recognised by English law.

anthropomorphic link between the individual and the corporation[39]. What appears to be replacing the attributive link between individual responsibility and the corporate body is now one between safety culture and the corporate body.

2.6.4 Is Safety Culture a Foreseeable Risk?

The idea of corporate culture becoming recognised in itself as a means to attribute corporate liability has been used for some time in English law, however the approach is gaining more traction. As an example, Slapper (1993) noted that it was the background to the prosecution's case against the parent company of the *Herald of Free Enterprise*, P&O (Peninsular and Orient Shipping Company). The case concerned the capsizing and sinking of a ferry outside the port of Zeebrugge after the crew left the ships bow doors open as the ship set sail. In *R. v P&O Ferries (Dover) Ltd*, the case against the holding company, P&O[40] failed. The law concerning corporate manslaughter was insufficient at the time to find guilt in the actions of the senior management. The requisite identification of direct causal involvement of a senior manager was one crucial element that the prosecution failed to establish[41]. A further defence submitted by the defending company made use of safety statistics that demonstrated that the existing procedures had seen some 60,000 sailings without incident, (Slapper, 1993). The necessity to identify a controlling mind (identification doctrine, see Table 2-4) has been largely set aside under the CMCHA as discussed earlier in this chapter and the reliance on the perfunctory use of statistics is less convincing under contemporary legal doctrine. With the prosecutorial gift of hindsight, the association of poor safety culture could be construed by public and legal opinion as a significant risk to organisational safety. Almond (2008) suggests the concordance between law and public opinion is changing social attitudes to corporate liability. The result may be that a reducing number of traditional defence strategies based on the complexity of causal relations are available to malfeasant organisations.

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[39] Denning LJ provided a famous anthropomorphism of the 'corporate body' in *Bolton (Engineering) C0. Ltd. V Graham & Sons Ltd.* [1957] 1 QB 159, in likening the body corporate to that of the human body, "It has a brain and a nerve centre which controls what it does. It also has hands which hold the tools and act in accordance with the directions from the centre."

[40] (1991) 93 Cr App Rep 72

41 Following Tesco v. Nattrass [1972] AC 153, HL and Attorney-General's Reference (No.2 of 1999) [2000] QB 796, CA.

In *R v British Steel*[42], it was noted that, "[a] company could not escape liability by showing that, at a senior level, it had taken steps to ensure safety if, at the operating level, all reasonably practicable steps had not been taken... a company, in other words, falls to be judged not on its words but its actions, including the actions of all its employees". In the more recent case of *R v Tangerine*[43], Lord Justice Hughes commenting on the employer's responsibility to consider foreseeable risk following the death of an employee in a sweet making machine, commented, "They command an enquiry into the possibility of injury. They are not limited, in the risks to which they apply, to risks which are obvious. They impose, in effect, a duty on employers to think deliberately about things which are not obvious." In assuming a level of foreseeability from the corporate body, the courts imply a mental element to the legal systems perception of corporate liability. If the legal system wishes to influence the corporate mind-set then perhaps that is where the responsibility for organisational safety culture could sit.

2.6.5 Changing Social Risks

As safety culture becomes aligned with the legal system, it cannot avoid the significant and increasing influences from the media. Its causal role in the quality of organisational safety performance creates an assumed legal standard of acceptable risk. The impact of media coverage of air accidents has been linked to alterations in the public's risk perception, (Young et al, 2008; Pidgeon *et al*, 2008), a fall in stock prices (Kaplinski & Levy, 2010) and even linked to perceptions of our own health, (Vasterman et al, 2005). The developing level of corporate liability is symptomatic of increasing social anxiety about levels of acceptable risk (Giddens, 1999; Perrow, 1999). To mitigate these fears, improved models of complex causation are needed. The application of safety culture to explain has perhaps superseded its real potential as an influencing mechanism to curtail excesses in corporate risk taking.

Bernstein (1998) describes emergent themes in our collective notion of acceptable levels of risk. He states that social fear of uncertainty has evolved from the recognition of inadequate explanatory function of social risk throughout the twentieth century. An

[42] [1995] 1 WLR 1356
[43] [2011] EWCA Crim 2015

inability to explain the function and process of the world around us, encourages fear of uncertainty at any level, but rapid technological advances, accentuate the effect Almond (2007). Bernstein gives a thorough explanation of deeper historical foundations dating back to Greek and Roman philosophies. However, much of contemporary risk attitudes changed rapidly after the mass loss of life across broad sectors of socio-economic groups during the First World War. Formulated from the decision-making principles of the financial markets, risk management soon found appeal in the broader fields of social science (Beck 1992; Berstein 1998; Giddens 1999). The concept of risk and its relationship with the criminal justice system inherited a wider descriptive role through the work of Michael Foucault (Rabinow, 1984). Foucault describes the use of criminal justice as a risk sharing mechanism rather than an indication of risk process failure. Following on from Foucault's theory, Faure (2014) claims that unacceptable and persistent societal risks are increasingly distributed through the mechanisms of the criminal justice system, civil litigation and insurance. Safety culture influences all these areas and provides a palatable explanation of complex failures.

2.6.6 Risk Society and Safety Culture

Beck's (1992) description of our 'Risk Society' underlines many contemporary and emerging attitudes towards safety culture and its function as a tool of social risk management. Beck highlights three significant features of society's management of new technology and complex risks. Firstly, that these risks are created by organisations and institutions who are then supposed to manage and control them. Safety culture is seen as a suitable mechanism with which risk can be mitigated in complex systems. Secondly, the magnitude of the risks is a direct function of the quality of the social relations and processes. Safety culture is the manifestation of the socio-technical interface between social relations and technical process. Thirdly, that the primary risk is that of social dependency on the institutions and actors which are remote and inaccessible to the majority who will be affected by those risks. An effective safety culture promotes open reporting systems which inhibit the separation of technocratic dependency by exposing complex functions to open scrutiny. Beck highlights the crucial relationship between technological development and societal responsibility; he emphasises the principle that the management of risk, which includes safety, is a responsibility of society rather than

individual actors. If, however, society is to take responsibility for its own safety and risk then explanatory models are needed to translate the complex agencies and systems that exist within it. Safety culture is in this sense the ideal mechanism to translate the causal relationship between increasingly complex systems and the societies they are supposed to serve. Promoting the development and training of safety culture within organisations can not only promote safety resilience through behaviour but mitigate social insecurities about risk through improved understanding, (Maiti et al., 2004; Townsend, 2016).

2.6.7 Cost Benefit Analysis

Beck (1992) suggests that many contemporary risk management techniques are associated with 'industrial society', a society that had been overly focussed on actuarial descriptions of risk tolerability. Tolerability refers to a level of risk that is absorbed without further mitigation in order to obtain benefit, (Gadd, Keeley and Balmforth, 2004). As an example, the Health and Safety Executive commissioned a study of acceptable and tolerable risk following public concern about the Sizewell B Reactor in the United Kingdom, (HSE, 1988). Foucault (1979) identified a rising tide of experts apparently skilled in the art of explaining new and specialised risk management techniques. The individual evolution of these separate specialisations of risk control has resulted in diverse and occasionally contradictory risk management philosophies, described by Hood & Jones, (2003) as the 'risk archipelago'. The tolerability of risk based on principles of cost/benefit analysis have on occasion proved to be particularly unpalatable by society. Braithwaite, (2001) identified one possible influence on the high performance of the Australian aviation community as the rejection by key figures in the Civil Aviation Authority on formulaic approaches to the risk tolerability of loss of human life. The disassociation of society from normative mechanisms of safety and risk control is at least partially behind a reactionary shift of society expressing its dissatisfaction and fear by the occasional use of the criminal justice system, (Almond & Colover, 2010). Linking the homogenous concepts of safety culture, accident causation and corporate liability is not necessarily an intuitive leap of philosophy and social science, but arguably a potent and effective social risk management policy.

2.6.8 Corporate Manslaughter in the UK

In what is arguably the most significant statutory response to social intolerance of

corporate involvement in unlawful deaths, the Government of the UK introduced the Corporate Manslaughter and Corporate Homicide Act 2007 (CMCHA). The Act came into effect after a long debate as to how to best address corporate killing particularly following successive accidents in the UK. Examples such as those collated in Table 2, such as the capsize of the ferry *Herald of Free Enterprise*, the Kings Cross Underground fire, the explosion of the Piper Alpha oil rig and the Clapham, Ladbroke and Hatfield rail crashes, were highly influential events, which accelerated the UK government's adoption of the CMCHA, (Pinto & Evans, 2008: Johnson, 2008: Almond & Colover, 2010).

No longer restrained by the almost impossible requirement to identify the 'controlling mind' at senior management level, the CMCHA assesses the aggregate[44] performance of the company, in effect its safety culture[45]. To date, all the successful convictions under the CMCHA have been of relatively small organisation; the largest company to have been convicted at the time of writing, Lion Steel Ltd. had 150 employees with a turnover of £10 million, (Woodley, 2013).

2.6.9 Global Trends in Corporate Manslaughter

Initially reluctant to impose criminal liability on the corporate body, the civil systems of Europe have now started to adopt various statutes and rule amendments to bolster the law's deterrent impact against corporate manslaughter. Since the early 1990s, constitutional amendments in Austria, Finland, Switzerland, Denmark, Iceland and Norway, now facilitate various species of corporate criminal liability, (Donaldson & Watters; 2008, Forlin & Smail; 2014). Almond (2013), describes this trend as a 'quiet revolution', implicating the growing influence of the European Union, the United Nations, and the OECD[46] conventions (See Table 4).

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[44] 'A theory of aggregation arguably better captures the nature of corporate fault than a theory, which imputes to the company a crime of a particular individual. There are times when, as a result of employee negligence, victims are seriously injured. Negligence, however, is generally not deemed sufficient to warrant imposing criminal liability on an individual and therefore also insufficient … to hold a company liable for the agent's acts', Gobert & Punch (2003:84).

[45] S.8.3(a) of the CMCHA invites a jury to 'consider the extent to which the evidence shows that there were attitudes, policies, systems or accepted practices within the organisation that were likely to have encouraged any such failure…. or to have produced tolerance of it'.

[46] The Organisation for Economic Co-Operation and Development is an international organisation of 34 countries which aims, through co-operation to advance ideas and review progress in specific policy areas, such as economics, trade, science, employment, education or financial markets.

Established on the legal principle of *respondeat superior*, the United States, corporate liability is based on the company's vicarious liability of its agents. Providing the agent reasonably believes that in their malfeasant act, they are acting in the company's interests, the responsible company may be found criminally liable. Although there is no statutory corporate manslaughter offence at Federal level, a 'model penal code' does include the concept and has been adopted by some States, (Gobert &Punch, 2003; Weissman & Newman, 2007).

The Canadian model of corporate liability is based on the acts or omissions of senior management. Following the Westray mining disaster in 1992, (see *Tables 3-1 and 3-2*), the Canadian government embarked on a path of constitutional reform. The resultant Bill, C-45, 'The Westray Bill', was brought into effect in 2004, although not as far reaching as the UK's CMCHA, it introduced corporate criminal liability, including corporate homicide.

The Australian authorities introduced the concept of aggregation to their criminal justice system, where the company has 'expressly, tacitly, impliedly authorized [sic] or permitted'[47] the offence by its agents or its corporate culture, Sarre (2010:4). The Australian authorities in the enactment of the Work, Health and Safety Act 2011 imposes on an officer of the company, a duty to uphold six elements of due diligence[48]. In summary, commentators have identified a global trend, that has begun to address public concern over corporate deaths by assessing the quality of corporate safety culture and utilising it to impute criminal liability, (Almond, 2013; Forlin QC & Smail, 2014).

2.6.10 The Criminalisation of Aircraft Accidents

Throughout the international agreements[49] and national procedures[50], which describe the purpose of air accident investigation, a single theme prevails; The purpose of an

[47] Criminal Code Act 1995 (Cth), Section 12.3(6).
[48] The nominated officer must uphold, knowledge of health and safety, their understanding of the hazards created by their business, resources and processes, risk reporting, legal compliance and verification of resource and process application, Work & Safety Act 2011(Cth), s.27 (5).
[49] ICAO (2010), Annex 13 of the Convention on International Civil Aviation (adopted 7 December 1944, commonly referred to as the 'Chicago Convention'), 10th Edn. Amendment 14, 14 November 2013, hereafter referred to as 'Annex 13'.
[50] National Authorities adopt ICAO's international standards and recommended practices then add their own additional elements to their statutory powers of air accident investigators. In the UK these are primarily the Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996. Within the membership of the European Union; EU Regulation 996/2010 governs the investigation and prevention of aviation accidents and incidents.

investigation into an aircraft accident is to prevent re-occurrence and preserve life. "The sole objective of the investigation of an accident or a serious incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability", (ICAO, 2013). In contrast to air accident investigation, criminal standards are generally determined by society's collective intolerance of certain acts or omissions; these are judged by society to be unacceptable and some form of punishment is often imposed as a deterrent, sometimes to invoke justice or occasionally as simple retribution (Michalowski, 1985). It is inevitable that the industry will have to address changes in societal expectations, articulated by law, when multiple deaths occur. Dekker succinctly describes this change in social expectation, "Accidents are no longer accidents at all. They are failures of risk management", (Dekker, 2007:x).

2.6.11 Increasing Frequency of Criminalisation

The criminalisation of aircraft accidents describes the use of the criminal justice system against frontline operatives in aviation such as pilots, air traffic controllers, maintenance personnel and increasingly the companies that employ them (Michaelides-Mateou & Mateou 2010; Dekker, 2011; Trögeler, 2011). It has grown to an annual global average of slightly over three cases per year between 2000-2010[51]. With such low sample data, there can be considerable variation in annual figures and as the criminal process takes place under sovereign authority, there is no official record of the number of incidents at international level.

The difficulty in measuring the precise current growth trends in the number of events is further compounded by the invariably long periods of gestation that case investigation and compilation can take. For example, following the crash of the Air France Concorde near Paris' Charles de Gaulle Airport in July 2000, the various prosecutions of individual and corporate manslaughter took over a decade to process through the French legal system. Following the crash of Air France 447 (see *Table 3-1*), after six and a half years, both Air France and Airbus have been indicted, however a judicial decision whether to charge the companies is still pending at the time of writing. What can be determined from recorded observations of criminalisation compared with accident frequencies, is that

[51] The number of incidents of criminalisation recorded by Michaelides-Mateou & Mateou (2010).

whilst the numbers of aviation operators being involved in a fatal accident in the first decade of the twenty-first century has marginally decreased since the 1990's, the number of operators, or their employees then subsequently being subjected to criminal prosecution, during that period, had at least doubled[52].

2.6.12 Just Culture

In an effort to protect open reporting cultures by limiting the disclosure of reports and the identity of the reporter, credible regulatory efforts have been made by the European Union to promote principles of Just Culture[53]. Article 14 of Regulation (EU) No 996/2010, encourages member states to protect sensitive information produced from an accident reports for any use other than the promotion of flight safety. Article 1 of Regulation (EU) No 376/2014, makes the appeal once more that occurrence reporting should not be used to apportion blame or attribute liability. Although embedded within regulation these broad instructions effectively remain guiding principles. Recent developments in the UK's Courts illustrate that these guiding principles run against contemporary judicial opinion on the pragmatic balance between the protection of safety reports and the pursuit of justice.

Rogers v Hoyle[54]*,* a UK Court of Appeal case, concerned the admissibility of an Air Accident Investigation Branch (AAIB) report into a civil claim for damages following the death of a passenger in a light aircraft. The significance of the case to broader issues of public safety were recognised by the court and submissions were invited from The Secretary of State for Transport, IATA, and the Chief Inspector of the AAIB, Mr Keith Conradi. These organisations claimed inter alia, that admission to court proceedings would provide a deterrent to open disclosure by witnesses and accident investigators mindful of the potential use of submitted material in court. The judge, Clarke LJ, was unconvinced by the deterrent argument. As both witnesses and investigators could be subpoenaed by representatives of civil claimants, the police or a Coroner's officer to give

[52] From Michalaedes-Mateou & Mateou (2010): 12 recorded incidents of criminalisation 1990-1999 (163.5 million global departures) and 31 recorded incidents between 2000 and 2010 (204.9 million global departures): Global Accident Statistics 1959-2015, UK CAA, CAP 1036.
[53] 'A just culture has been defined as a culture in which front line operators and others are not punished for actions, omissions or decisions taken by them that are commensurate with their experience and training, but where gross negligence, willful violations and destructive acts are not tolerated', Annex 13 ICAO.
[54] [2014] EWCA Civ 257

evidence it would be more likely that their anonymity under an inadmissible AAIB report would be removed as there would be no other way to obtain such evidence. Although the facts of *Rogers v Hoyle* were not directly related to commercial aviation, the content of the case report illustrates not only the complexity surrounding the relationship between safety critical industries and the law, but also the need for such industries to look beyond their own borders into a broader role of social responsibility. By regulating just culture into safety management systems, policy makers intended to promote safety reporting by establishing balanced mitigation to penalising individual error. Perhaps unintentionally, they have also invoked issues of corporate liability into safety management by moving the focus of liability away from the individual and by implication towards the organisation.

2.6.13 Explaining Criminalisation in Aviation

Commentators on criminalisation in aviation such as Michaelides-Mateou & Mateou (2010), Dekker (2011) and Hudson (2014) have successfully highlighted the potential damage that criminalisation causes to safety reporting. These writers have promoted just culture as a mechanism to mitigate the less desirable effects on reporting by legal intervention. They have adopted an interpretative[55] view of the function of law, having highlighted a series of unconscionable prosecutions without any apparent *mens rea* of the defendant operator accused of criminal activity after an accident. In effect, an interpretative perspective of the law of regulating safety culture would demand a clear and optimal definition, designed to maximise safety performance. Anything less would be unconscionable as interpretative legal standards are driven by moral standards concerning the potential loss of human life.

An alternative analysis, from the perspective of legal positivism[56], suggests that focussing criticism on the sometimes-amoral nature of the legal system fails to recognise the essential but broader social policy function that is demanded of it. Legal positivism might well embrace the ambiguity of the current legal state of safety culture. The uncertainty

[55] An interpretative perspective on jurisprudence partly concludes that there is no difference between law and morality. It is most recently expressed by Richard Dworkin's seminal work 'Laws Empire', (1986).
[56] Legal Positivism would suggest whatever ethical justification of laws are offered, they have to reflect societies' normative sense of morality, (Hart, 2012).

around the legal standards of safety culture would compel organisations to self-assess their vulnerability to post-accident prosecution, rather than rely on the proscribed standards of regulation.

2.6.14 The Effect of Criminalisation

Dunn, Colombo & Nold, (2009), describe two primary effects of criminalisation. The first, is the physical restriction placed around an aircraft crash site, restricting timely air crash investigation activity. Secondly is the more insidious and long-term effect on open reporting of safety information. It is the fear of sanction, which criminalisation promotes, that impacts on reporting behaviours and the effectiveness of safety management systems, (Dekker, 2003, 2007, 2011; Thomas, 2003, 2007; Dunn *et al*, 2009; Michaelides-Mateou & Mateou, 2010; Trögeler, 2011; Townsend, 2013).

A further effect is more insidious and relates to corporate liability. The promotion of SMS, (Safety Management Systems, now formalised as international Standard and Recommended Practice through Annex 19 to the Chicago Convention published in 2013 (ICAO, 2013a)) and its related output of documented descriptions of how safety and risks are actually managed, will provide a rapidly expanding evidential database of corporate policy, process and decision-making. Should corporate fear of exposure to retrospective analysis by the criminal justice system, inhibit open reporting or the effective dissemination by companies of safety intelligence gathered through SMS, then organisational learning would be inhibited. This remains one of the greatest challenges to the effectiveness of SMS across commercial aviation and other industries at operator, national and international level, (GAO, 1997; FSF, 2010). This is particularly pertinent to corporate mind-sets given the adoption by multiple jurisdictions of various forms of corporate manslaughter.

2.7 A Summary of the Literature Review

In assessing the literature concerning the legal standard of safety culture this review covered distinct but inter-relating disciplines. The review was split into five sub-sections which are summarised below:

1. Safety Management: The first part of the review described the mechanisms of safety management within commercial aviation. Many of the metrics of safety performance where devised from a much simpler period of aircraft operation. Whilst the system has achieved a remarkable level of safety performance, the exponential changes in technology and complexity demand more sophisticated lead indicators. One of these indicators could be the ability to manage organisational cultural influences.

2. Organisational Culture: Considerable research focus has been directed at the influence of culture within organisations. Organisational theory has evolved from a predominantly positivist perspective to one challenged by real world ethnographic study. A degree of consensus now seems to have been reached with the recognition that combining the functionalist with real world validation produces a more robust theoretical construct. Based on this premise new models are required to interpret this complex interaction.

3. Safety Culture: Reflecting many of the theoretical characteristics of organisational theory, safety culture has seen two broad approaches to research. The functionalist perspective describes safety culture as a characteristic of an organisation whilst interpretative perspectives culture as a metaphor for what the organisation is. Regulating safety culture provides something of a dilemma. Producing definitive aspirational standards has proved to be ineffective and occasionally counter-productive. Leaving ambiguity as to the required level of safety culture leaves an open door to the vagaries of the criminal justice system. A legal standard of safety culture cannot be an effective deterrent strategy to poor corporate governance if it

is unpredictable or illogical. In this uncertain environment of risk and liability management, the pursuit of a defence of due diligence through enhancing safety culture is suggested as a management goal.

4. Causation: If effective safety culture cannot be entirely driven by regulatory mechanisms then it will be subjected to broader legal process. Three main arguments are proposed suggesting that safety culture could be considered as complying with the conceptual framework surrounding causation. Rather than providing achievable corporate goals, the adaptable notion of safety culture provides a convenient explanatory tool for the judiciary in implicating organisational conduct into the aftermath of organisational failure.

5. Corporate Liability for Accidental Death: The increased numbers of events where the criminal justice system has intervened in aircraft accidents represents a broader shift towards social distrust of established mechanisms of risk control. Within an increasing number of jurisdictions, an organisation that is involved in a fatal accident is subject to an automatic and thorough assessment of its risk and safety process. Should that assessment reveal inadequacies, an increasing number of jurisdictions are implementing legislation to enable the prosecution of corporate manslaughter charges. It is therefore incumbent on any effective corporate risk management process to have an up to date knowledge of its safety culture and the ability to manage it towards a defence of due diligence.

Table 2-1 Possible Strategies of Regulating Safety Culture

STRATEGY	DESCRIPTION	ADVANTAGES / DISADVANTAGES
INTERNATIONAL REGULATORY STANDARD OF SAFETY CULTURE	Regulator defines an industry standard (or a standard set of attributes) of safety culture; one international standard.	This approach would provide clarity as to the nature of industry safety culture and the required standard of safety culture possibly benchmarked against other operators. It would provide a measurable international standard. Unless adapted (Noort *et al*, 2016) the approach could ignore leading indicators of safety behaviours associated with national culture, Hudson (2007). It could also inhibit continual improvement, as noted by Grote (2007).
NATIONAL STANDARDS OF SAFETY CULTURE	National aviation authorities assess their own safety culture that adapts to the particular characteristics of the nation and its cultural and legal environment.	As the regulator can co-ordinate development within a singular jurisdiction then national cultural behaviours are adapted into the regulatory structure. In providing a benchmark within national standards (Kim & Choi, 2016). However, the very nature of international commercial aviation means multi-cultural interaction is inevitable and needs to be considered, Reader (2015). Experience in the nuclear and petro-chemical industries suggest strong tendencies for the regulator and the operator to have very different interpretations on what effective safety culture looks like, Kringen (2013).
ORGANISATION DEFINED SAFETY CULTURE (BROAD PURPOSIVE).	Basing a safety culture definition adapted to each organisation allows a more purposive and flexible approach tailored to each organisation.	As each organisation effectively develops its own cultural traits, trying to adapt to a generic model might be ineffective. This approach could produce models of safety cultures rather than one specific definition. This approach may lack a degree of objectivity and could be rather descriptive, Grote & Weichbrodt, (2013). Organisational self-awareness may not develop as no benchmarking facility would develop, Dempsey (2010). The organisation may develop standards that fall below common industry or broader socially acceptable standards of safety and risk management, Hopkins (2006).
NO SPECIFIED REGULATORY STANDARD OR DEFINITION OF SAFETY CULTURE	The regulator provides nothing more than guidance as to best practice. Operators are merely compelled to assess and record their safety culture as part of their SMS.	Differences in national and cultural norms are partially offset as the organisation determines its own acceptable standard of safety culture. Enforcement is not a regulatory strategy as the low level of fines and minimal impact of enforcement orders do not induce the long-term process of safety culture development. The incentive to develop safety culture is derived from the significant financial and public relation impact of prosecution by the criminal justice system.

Table 2-2 Generic Models of Corporate Criminal Liability

STRATEGY	DESCRIPTION	ADVANTAGES/ DISADVANTAGES	EXAMPLES CASES	EXAMPLE JURISDICTIONS
INDIVIDUAL CRIMINAL LIABILITY	No specific corporate criminal liability offences exist. Where executives engage in egregious conduct they can face individual criminal liability. Companies may face administrative fines for wrongdoing.	The main advantage is that in principle individuals bear responsibility for their own sphere of responsibility; more senior management carry more responsibility. In reality this can encourage blame transference from the corporate body to an individual; 'scapegoating'.	Meltdown of the Fukushima Nuclear Reactor, 2011. TAM Airlines Flight 3054, Sao Paolo, Congonhas Airport, 2007	Brazil, Bulgaria, Germany, Greece Luxembourg, Hungary, Japan, Mexico, Slovak Republic, Sweden.
IDENTIFICATION PRINCIPLE	The criminal liability of the corporation is derived from identifying a sufficiently senior 'controlling mind', that had sufficient authority and association within the company. In some jurisdictions it can expand to the mere lack of supervision of lower-level employees.	The offence links the behaviour of significant individuals within the corporate body to the organisation at large, in theory providing deterrence against inappropriate activity. In some jurisdictions, the necessity to identify the sufficiently senior executive is too narrow to be effective. Also, the nature and complexity of modern companies blur the causal link between executive decisions and corporate fault.	The Westray Mining Explosion, Novia Scotia, 1992. Crash of the Helios Airways Flight, Boeing 737, near Athens: 2005	Canada, China, Cyprus, India, Ireland, New Zealand.
VICARIOUS LIABILITY	Based on the the dictum of 'respondeat superior', organisational liability is based on the non-delegable responsibility of an employer for the acts of employees. The offending act may have to be negligent or to benefit the organisation.	The flexibility of this doctrine has allowed successful convictions against corporate bodies but it has been consistently criticised as being too broad in its applicability. For example as under Danish law the defendant company's sometimes considerable efforts to maintain the compliance of employees is effectively ignored.	Explosion of the BP Deepwater Horizon Oil Rig, 2010. Crash of Air France, AFR 4590, Concorde, F-BTSC, Paris, 2000	Bulgaria, Denmark, France, Norway, Russia, Federal law of the United States of America.
SPECIFIC CORPORATE LIABILITY	The corporation is recognised as having its own legal personality and can embark in illegal activity. Under UK law, CMCHA, rather than focussing on the acts of individuals, liability is based on the aggregate performance of the organisation. Sometimes referred to as the 'aggregation doctrine'.	The aggregate performance of a corporate body is considered a more representative assessment of an organisation's safety culture. To date there have been no convictions of large, multi-national corporations which would provide the acid test of this strategy's effectiveness to deal with the causal complexities of modern commerce.	*R v Cotswold Geotechnical Holding Ltd* [2012]: first case under UK's CMCHA. *Rechtbank Leeuwarden* [1987]: first case of corporate criminal liability under Dutch law.	Australia, Romania, The Netherlands, United Kingdom.

3 STUDY ONE – A Grounded Theory of Due Diligence: d3SC

3.1 Introduction

In assessing how the aviation industry learn from error, Salas, Burke, Bowers & Wilson (2001), identified a key failing in interpreting the output from the case study of accidents in understanding individual and organisational behaviours; the focus is almost entirely on the fault of the actions of those involved. To improve safety performance an understanding how to promote positive behaviours is required. Due diligence is the antithesis of fault. Gobert & Punch (2003) and Pinto & Evans (2008) *inter alia* have posited that to promote best practice within any industry a defence of due diligence should be made available to promote best practice. From the literature it is apparent that various criminal justice systems have identified safety culture as a mechanism to impute liability. Developing a model which links safety culture to safety related liability could underpin a defence of due diligence through safety culture or 'd3SC'.

3.1.1 Aim of the Study

This study aimed to develop a prototype d3SC model through the identification and comparison of attributes of legal causation identified in accident reports that have been associated with safety culture. The study is a progression towards the linking of metrics of safety culture with metrics of corporate liability in commercial aviation. Rather than develop a purely functionalist or over-arching theoretical tool, this study's objective is to allow the incorporation of multiple elements of real world data from technical and legal case studies. To achieve that balance the study used a process of grounded theory from which a conceptual model is developed. By identifying how accident reports, investigations and legal case studies link attributes of safety culture to accident causation, a theoretical model emerged by combining common themes that are derived from evidence-based data. The ultimate purpose of the emergent model is to facilitate a defence of due diligence to corporate manslaughter with which organisations are incentivised to develop their safety culture. The data sources of accident case studies are presented in two tables sequenced at the end of this chapter.

3.1.2 Context

One of the key purposes of developing a safety culture model linked to corporate liability is to provide an element of prediction or certainty to corporate risk management process. Without consensus of what constitutes a legal standard of safety culture, in the event of a high-profile accident with prima facie evidence of organisational failure, prosecutors and accident investigators, will search for a causal explanation. Dekker & Nyce, (2011), in exploring the influence of 'folk-models' of causation within accident reports, point to the basic human need for causal explanation, described by Nietzsche, (1889) as 'caused or aroused' by a fear of the unknown[57].

This ambiguity was noted in the literature which identified that many accident models possessed more descriptive than analytical qualities (Hopkins 2014). Reader & O'Connor (2015) attempted to identify the human factors characteristics which lead to the Deepwater Horizon explosion (National Commission, 2011). Their approach attempted to explore how cultural influences affected human activities but failed to identify how these actions were influenced or linked to senior management practice. Whilst an aircraft accident is formally defined within international convention, (ICAO, 2010), the concept of an organisational accident originates within a system thinking approach; the approach recognises the influence of organisational culture on risk perception and therefore individual behaviours, (Cooper, 1997; Reason, 1997; HSE, 2007; Woods, D. D., Dekker, S., Cook, R., Johannesen, L. & Sarter, N., 2010; Leveson, 2009, 2011a). Linking the values and attitudes which pervades the whole organisation is key to establishing the causal role of safety culture.

In corporate law, theories of corporate crime and organisational failure have also identified a shift away from the traditional view of the corporation, described by Jensen & Meckling (1976) as a 'nexus of contracts', towards a more holistic or organic concept of corporate functionality, (Johnson, 2008; Kirk, 2012; Forlin & Smail, 2014). This emerging perspective of the corporation as an entity shares very similar characteristics to

[57] "First principle: any explanation is better than none. Because it is fundamentally just our desire to be rid of an unpleasant uncertainty, we are not very particular about how we get rid of it: the first interpretation that explains the unknown in familiar terms feels so good that one 'accepts it as true'. We use the feeling of pleasure ('of strength') as our criterion for truth. A causal explanation is thus contingent on (and aroused by) a feeling of fear", Nietzsche, (1889:5).

the holistic notion of organisational culture promoted by Schein (1996, 2017). The recognition of these common organisational traits under the collective term of safety culture is broadly the evidential link to corporate criminal liability in the event of fatal accident (Wells, 1996, 2001; Donaldson & Watters, 2008; Almond, 2013; Forlin & Smail, 2014; Hopkins, 2015). Understanding and managing these emerging phenomena by developing a model of defence of due diligence against a criminal prosecution could also enhance safety performance in commercial aviation.

3.1.3 Research Challenges

There are a number of challenges relating to this type of research. The first was described in the literature review and relates to the small sample size due to limited data. Accidents that attract the level of resources which produce formal and in-depth reports are rare events. It is the rarity of these events which attract public, investigative and research interest but similarly they provide marginal sample numbers with which paradigms can be developed (Salas *et al*, 2001; Hopkins, 2015; Strauch, 2015). This limits the availability of research methodology and curtails the level of confidence for subsequent modelling. The scarcity of data from commercial aviation was partially overcome by initially referencing some data from generic case studies from other safety critical industries.

The data sources required a degree of contextual interpretation as each type of report, be it legal or accident investigation report come from very differing epistemic perspectives. Both use differing terminology derived from the context of the report. For example, data derived from legal case studies contained some legal terms of art which by design, infer or impute liability. In contrast, accident investigation reports are designed to present a balanced field which ultimately produces nothing more than 'probable cause'. The data sources are not sources of empirical evidence *per se* but require contextual interpretation in order to de-construct them from the purposes they serve (Strauch, 2015). Rather than pursue the scientific objectivity associated with quantitative research, qualitative interpretation recognises its inherent subjectivity derived from the experience, training, assumptions, knowledge and inherent biases of the researcher (Corbin & Strauss, 2015; Holton & Walsh, 2016). This approach requires what Corbin and Strauss described as

'sensitivity' to the subject matter, which requires a degree of self-awareness with which concept development can progress towards theory.

3.2 Methodology

3.2.1 Overview

An analysis of twenty-six accident reports and over fifty reported legal cases[58] were undertaken and listed in *Tables 3-1 and 3-2*. In order to identify codes and categorise the causal attributes of safety culture, a grounded theory approach was adopted. To develop a new model that links safety culture with corporate liability, patterns and common themes within numerous reports were identified. The Part One data set (presented in *Table 3-1*) comprises of high profile accidents which have come to represent the more established associations between safety culture and corporate liability identified across a broad array of industries which provided an initial benchmark of coding[59] categories. The Part Two data (presented in *Table 3-2*) allows further analysis of cases specific to commercial aviation.

3.2.2 Grounded Theory

Grounded theory is a process of data analysis and can also refer to a type of theory that is grounded in data (Holton & Walsh, 2016). The flexible data collection processes associated with grounded theory allow and promote the requisite level of creativity (Glaser, 2016; Holton & Walsh, 2016). The flexibility afforded by this approach allowed the incorporation of differing academic and professional principles into one cohesive model. Thematic analysis was considered as a method with which to identify, analyse, report and describe elements of the data sources (Braun & Clarke, 2006)[60]. Arguably the process of thematic analysis sits within the epistemic boundaries of grounded theory, but the emphasis on emergent characteristics produced through the iterative coding process

[58] Many of the cases were investigated by prosecutorial as well as accident investigation agencies. The rules of precedence require reference to previous authoritative cases. As such it is impossible to reference each individual case as each decision may be based on multiple prior decisions. The estimate of 'over fifty' cases is a conservative estimate of the number of actual cases read and referred to.

[59] Coding refers to the deciphering and interpretation of data and 'coding' the concepts into named groups (Böhm, 2004; Holton & Walsh, 2016).

[60] Content Analysis was used in Study Three as a mechanism to compare emergent themes from interview data used to triangulate d3SC output. A similar and sometimes overlapping method of data analysis to thematic analysis, content analysis is an appropriate method to conceptualise interview and open questionnaire data.

of grounded theory was considered to be a more desirable output of this study rather than that of thematic classification. Accident reports are designed to provide a rich data source in a clear unambiguous format. In contrast, the majority of legal sources do not sit within the academic journals or textbook of safety science. Legal discourse originates from a separate epistemic origin than that of safety science. The initial coding and memoing process not only facilitated the recognition and development of patterns, emergent links and comparisons, but crucially allowed sense to be made of the subject to hand. The adopted process in this research process was not entirely 'free-hand' in the Glaserian style but more akin to a Straussian semi-structured accumulation of data, (Corbin & Strauss, 2015; Holton & Walsh, 2016).

3.3 Memoing

3.3.1 Part One - Generic Examples of High-Profile Accidents

The case studies in *Table 3-1* were collated as examples of high-profile accidents which had prompted subsequent public inquiries and occasionally criminal investigations. *Table 3-1*, is by no means exhaustive and is included to provide a chronology of some of the higher-profile accidents and associated attributes of safety culture that have been recognised and broadly accepted as a contributory cause. High-profile accidents will often attract more investigative resources and can hold considerable political currency, (Hopkins, 2006; Hollnagel, 2014). As such these investigations often look deeper into the organisational influences behind the proximate causes. *Table 3-1* highlights the attributes, i.e. the 'values and attitudes' highlighted by Piers *et al*, (2009), of safety culture, as identified by the accident investigation report or the subsequent criminal investigation. The example accidents are presented with a brief explanation of the causal role of safety culture identified in the report.

3.3.2 Part Two - Commercial Aviation Accidents

The second phase of data shown in *Table 3-2* is sourced from commercial aviation related case reports. All the reports had identified safety culture as a causal contributor to the accident and each accident had resulted in some form of legal action. Similar to the characteristics identified by Piers *et al* (2009), the reports and inquiries use contextual phrases or attributes of the relevant organisations safety culture, rather than a generic or

all-embracing definition. Academic attention on the criminalisation of aviation accidents, predominantly focussing on individuals, emerged through the 1990s (Dekker, 2003) but the link between corporate culture and corporate liability attracted significant academic interest through the first decade of the twenty-first century (Donaldson & Watters, 2008). The accident case studies were therefore selected from those reported and released post-2008 that had been identified in studies by Michaelides-Mateou & Mateou (2010), Dekker, (2011), Trögeler, (2011) and Nemsick & Passeri, (2012).

3.4 Coding

3.4.1 Overview

The initial codes were derived by memoing[61] each characteristic associated with safety culture within the context of corporate liability. Strauss & Corbin (1998) suggest there are only a limited number of questions the researcher needs to ask when initially analysing the data: 1) what is the data a study of, 2) what category does this line or incident (group of lines) indicate and 3) what is actually happening in the data? This process keeps the contextual meaning of the data whilst allowing themes to emerge from the data set from the various form of cases. The case studies produced an overview of the causal influence of safety culture; as has been repeated throughout this research, safety culture can be represented as an overarching construct or as a collective of organisation features or attributes.

3.4.2 Part One – Coding High Profile Accidents

Following Strauss & Corbin (2015) and Böhm (2004), a structured review was made of thirteen high profile incidents where safety culture was identified as a causal factor. In *Table 3-1*, the accident report or subsequent criminal investigation, had identified one or more attributes of safety culture as a causal factor[62]. Each case was assessed to determine what aspect of safety culture was identified as a contributory cause of the accident. Through open-coding the attributes of safety culture identified by the accident investigators were noted and where appropriate, the findings of any legal investigating

[61] Memoing refers to a method of noting and comparing emergent concepts from the analysis of data (Holton & Walsh, 2016).
[62] For non-English reports, Google Translate was used to provide an appropriate search phrase and minor alterations were made to accommodate differences between English and American English spelling.

body. A synoptic of the causal role, as described by the report is contained in the listing of *Table 3-1*.

Many of the reports, (IAEA, 1992; Cullen, 2001; ORR, 2006; CAIB, 2003; Haddon-Cave, 2009; National Commission, 2011; Kurokawa; 2012), made specific references to operating, company, organisational and safety culture. These reports generally focussed on the influence of senior management or policy level activities. Other reports described the 'values and attitudes' similar to the broader definition of safety culture used by Piers *et al* (2009). These include 'organisational decision-making', (NASA, 1986), the 'low priority of safety issues', (Department of Transport, 1988), 'inadequate training', (Hidden, 1989), 'lack of reporting or feedback', (Cullen, 1992), and management knowledge or condoning of 'unsafe practice', (Richards, 1996).

Constant comparison analysis revealed some differentiation from the initial Part One data and resulted in further generic codes of causal attributes: Senior Management Commitment; Management Knowledge of Unsafe Practice; Lack of Leadership; Inadequate Procedures; Poor Prioritisation; Operating Regime; Operational Decision Making; Operational Risk Management; Rule Breaking; Deteriorating Safety Culture; Inability to Communicate Safety Messages; Organisational Learning; Development of Sub-Cultures; Values and Attitudes.

3.4.3 Part Two – Coding Commercial Aviation Accidents

In *Table 3-2* thirteen examples of post-2008 commercial aviation accidents were analysed using same coding process from Part One where safety culture had been identified as a causal explanation. The coding confirmed the emphasis on senior management influence and a significant lack of alignment between formal safety processes and with operational standards. Some case studies tended to be broadly descriptive as safety culture was used as a broad overarching term rather than stating specific examples of organisational failure[63]. Other reports did have some differences to those in *Table 3-2*; in highlighting rule-breaking and secondly in informal or poorly communicated safety messages between

[63] Examples are the Value Jet accident and Air France 447 which discussed an unspecified link with safety culture and standards of non-technical skills.

senior management and operational staff[64]. The main operational effect of these traits were the breaking of rules and deviation from standard operating procedures (SOPs). In two of the case studies scarce resources allocated to safety processes were associated with poor safety culture and safety management[65]. Constant comparison analysis of the codes revealed further causal groups outside of the initial codes identified in Part One. The further codes groups were: Management of Change; Incorrect Procedures; Manpower Levels; Operational Competence; Productivity Compromising Safety; Procedural Informality; Communicating Values. Within the constraints of the case study saturation was considered when further codes were not identified after re-analysis of all case studies in *Tables 3-1 and 3-2*.

3.5 Categorising

3.5.1 Overview

The initial memoing and open coding process produced twenty-six discrete initial codes; saturation was considered to have been achieved when no further codes were forthcoming. The codes were categorised according to their causal association within each organisation. Corbin & Strauss (2015) describe a process of evolution from lower-level categorisation, categories and eventually towards a core category. To maintain the context of each category in terms of organisational or corporate liability, two elements were considered necessary to be retained in the model; the hierarchical perspective from within the organisation and the causal role which implicated the organisation's safety culture in the accident. The hierarchical levels referred to by corporate law are generically described by case law[66] and legal commentators as senior management, middle management and employee or operational levels (Slapper, 1993; Gobert & Punch, 2003; Pinto & Evans, 2008; Wells, 2010). The causal elements of the model were related to relate to models of corporate liability such as those described in *Table 2-2*.

[64] These examples include the Gol Air air-to-air collision with a Boeing 737 in Brazil and the TAM Air accident at Congonhas Airport.
[65] The air-to-air collision over Überligen and the Alaskan Air accident both identified scarce resource in company safety management.
[66] See Tesco v Natrass Following *Tesco v. Nattrass* [1972] AC 153, HL and *Attorney-General's Reference (No.2 of 1999)* [2000] QB 796, CA.

3.5.2 Hierarchical Categories

Through constant comparison analysis the codes were ranked into hierarchical levels with which the code was contextually associated with senior management; the higher position in the ranking order, the closer the association with senior management. The lower elements in the ranking order held more association with operational attitudes and behaviours while middle ranking codes related to middle management.

As discussed in the literature review, the various models of corporate functionality share a common association with senior management. The influence of senior management is the singular common theme of vicarious, identification principle and aggregate models of corporate criminal liability (see *Table 2-2*). The literature suggested that there is broad academic consensus on the pivotal role played by senior management in the effectiveness of organisational culture (Flin, Mearns, O'Connor & Bryden, 2000; Gadd & Collins, 2002; Flin, 2007; Leveson, 2009). Guldenmund (2007) envisaged three categories of hierarchy termed as organisational, group and individual. Guldenmund's perspective broadly aligned with the context of how each of the 'stories' of causal association took place and is illustrated in *Figure 4.*

The nine emergent categories were split into the three broad hierarchical categories described by Guldenmund (2007). *Figure 4* illustrates how multiple codes were merged into more generic categories of attitudes and values and their output, that is their associated symptomatic behaviours. This phase of the analysis process distilled down the initial codes or to what Gioia, Corley & Hamilton (2013) refer to as 'aggregate dimensions' of an emergent model. The 'aggregation' of the multiple perspectives of accident causation is perhaps an inevitable result of modelling complex behaviours and as *Figure 4* illustrates that the emergent hierarchical boundaries are not clear cut as many of the codes relate to categories above and below their original ranking. However, some form of a recognisable hierarchical pattern was evident. The next stage of theoretical development required some exploration of the causal relationships which linked these categories to recognised paths of legal causation.

3.5.3 Axial Coding of Hierarchy and Causation

Guldenmund (2007) and Hopkins (2014a) noted that while numerous studies had identified how organisations actually function these have not been satisfactorily explained in terms of their role as the causal mechanisms of accidents. A review of the data suggested that further interpretation was required to give a contextual explanation a process described by Strauss & Corbin (1998) as axial coding. "Concepts have to be woven or linked back together to tell the original main story of the research or observation but in conceptual terms", Corbin & Strauss (2015). For example, some of the codes seemed generic but actually applied to specific sections or departments within an organisation.

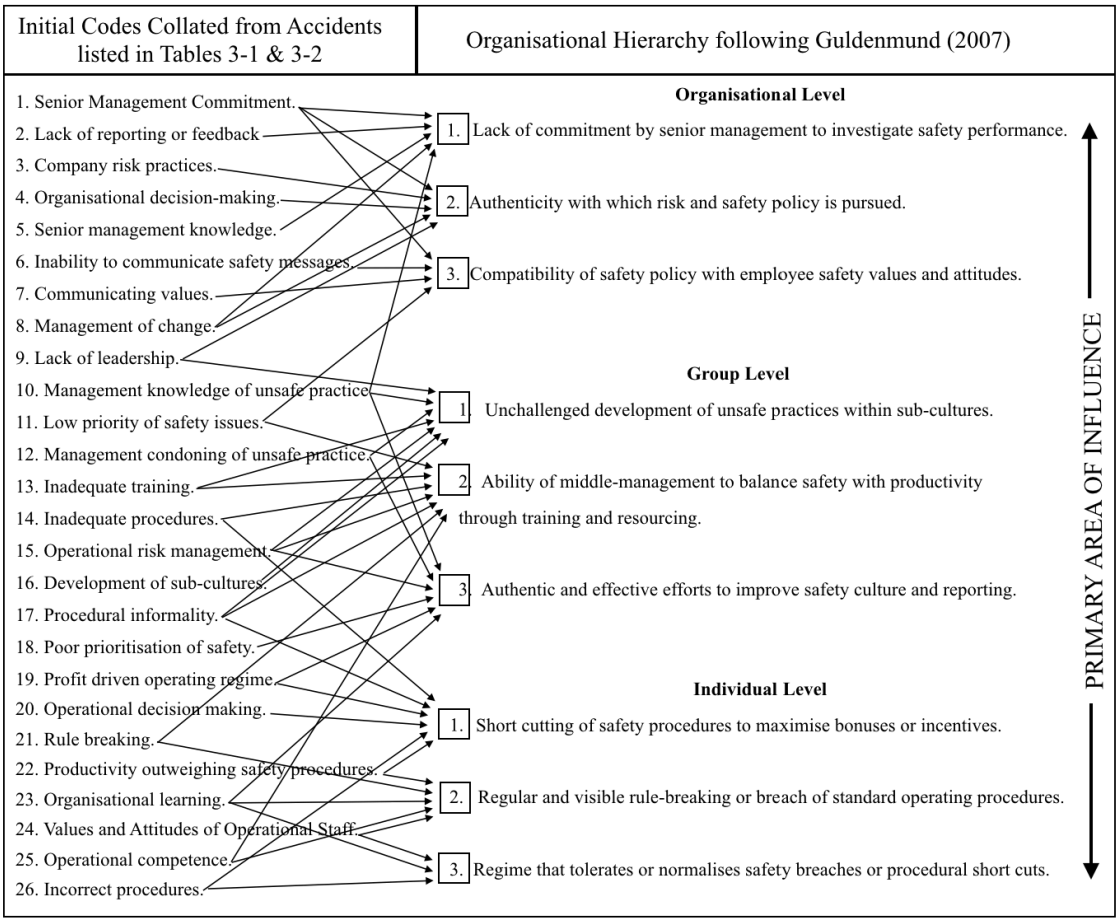

Figure 4 *A Synoptic of the Initial Coding and Categorising of the Causal Attributes of Safety Culture.*

The hierarchical setting of each code also needed further clarification; whether values and attitudes that compromised safety were identified within certain sub-groups of an

organisation or witnessed within a boardroom or policy level department has significant implications for the overall safety culture and particular implications for the potential liability of the organisation. Both the theory and case studies were emphatic in highlighting the influence of senior management commitment to safety but exactly how that influence was interpreted into operational standards was less clear. The hierarchical component of the model was relatively straight forward: the imposition of *organisational level* policy by senior management, *group level* middle management balancing a compromise between commercial viability and safety standards and finally the operational effectiveness of the workforce at *individual level*.

3.5.4 Weaving the Causal Categories

Figure 5 illustrates the output of axial coding process; comparing and arranging the causal categories derived from the case studies into a prototype model of the causal role of safety culture. The order of the model was achieved by constant comparison of the categories within the context of the case studies listed in *Tables 3-1 and 3-2*. The case studies revealed primary causal pathways (vertical) but also secondary pathways (lateral) through each hierarchical level. For example, the lack of commitment by senior management could result (vertical influence) in the unchallenged development of sub-culture but could also compromise (lateral influence) the authenticity of safety policy.

These causal pathways are effectively descriptive rather than based on pure causal philosophy. However, as described in *Table 2-2* the various models of corporate liability do represent a shift from identification models (direct), to those of vicarious liability (influenced) and ultimately towards (inferred) aggregate models (Almond, 2008; Donaldson & Watters, 2013). As described earlier, in paragraph 3.3.3 there was clear emphasis on the primary influence of senior management and this is reflected in the prominence of this organisational level in the causal pathway.

3.5.5 The Causal Pathways

Schein (1996) promoted a holistic approach to modelling organisational culture. The three elements of his organisational model were not necessarily defined in terms of hierarchy. The artefacts, values and underlying assumptions that run through his organisational concept are common to all levels. However, Schein does describe cause in terms of the

strong influence of functional cultural influences: positions and professions that are defined hierarchically determine inter and intra organisational function. The prototype model describes three primary causal pathways derived from axial coding; comparison of the categories with the case studies in *Tables 3-1 and 3-2*. The primary (vertical) causal pathways are described below.

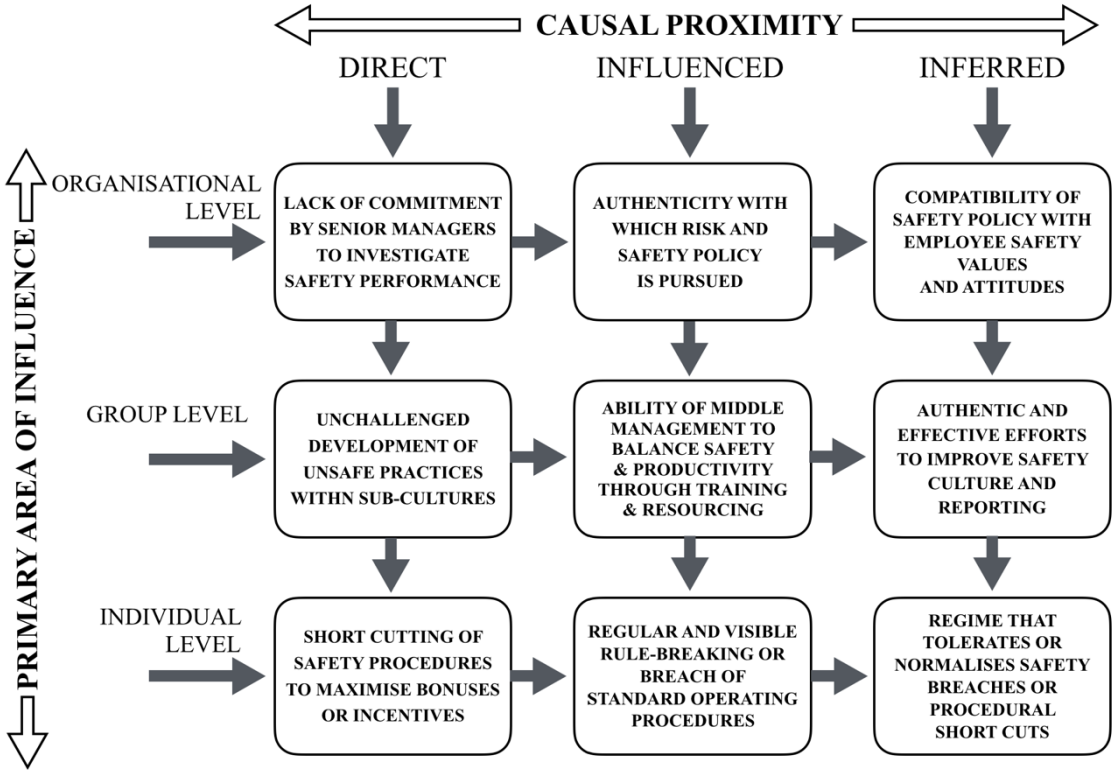

Figure 5 A prototype d3SC model describing the causal relationships through various strata of management through the attributes of safety culture.

3.5.5.1 Direct

In these examples, a lack of focus by senior management on safety performance results in the (sometimes rapid) development of sub-culture within the organisation (Fang & Wu, 2013). In turn these can form a culture were unsafe practices are condoned or even encouraged through incentives (Hopkins & Maslen, 2015). The literature on corporate liability referred to this phenomena as the effect of 'wilful blindness' of corporate leaders (Gobert & Punch, 2003; Pinto & Evans, 2008; Slapper, 2010; Wells, 2010). This pathway aligns with the philosophy of causal minimalists. The minimalist approach promotes a more traditional linear concept of causation based on the legal maxim of *sine qua non* or 'but for'. A classic example is the Westray Mining disaster were senior management allowed the managed teams to use naked flame torches in an underground mine known

to house flammable gases. Other examples were this causal pathway was described in the accident reports include Piper Alpha, Chernobyl, and the Hatfield rail disaster.

3.5.5.2 Influenced

This pathway reflects the influence of organisational level or senior management in the degree of authenticity with which they are perceived to enact risk and safety policy. The referred influence is that placed upon on middle management and group activity; if senior management do not prioritise safety then it is unlikely their subordinates will. As legal mechanisms such as *inter alia* the CMCHA have aligned corporate conduct with management conduct, the standard of safety becomes the necessary element of 'sufficient' set of causal conditions (Mackie, 1980). The 'sufficient' causal symptom of the degradation of these values and attitudes to safety is typically the breaking of rules or ignoring of standard operating procedures (Rasmussen, 1997; Perrow, 1999; Leveson, 2011b; Hopkins, 2014). An illustrative example is the sinking of the Herald of Free Enterprise; Lord Justice Sheen famously described an organisation 'infected with a disease of sloppiness'[67]. As the 1987 disaster pre-dated the CMCHA by twenty years, Sheen LJ was unable to bring to bear a criminal action for corporate manslaughter based on a causal link he and others had intuitively placed between the senior management of P&O and the conduct of the fateful crew.

3.5.5.3 Inferred

This causal pathway is a further development in the alignment of contemporary legal and organisational theory. Based on the premise that organisational norms are not static, it places an obligation at policy or senior management level to actively engage with the whole organisation rather than delegate risk and safety management principles to lower levels of hierarchy. Snook (1996) identified the concept of 'practical drift' in complex environments and Vaughan (1997) described a 'normalisation of deviance'. The contribution made by social science in recognising that active participation by those engaged at the most senior levels of safety critical organisations has evolved into a legal obligation, not a risk option. The extent to which organisations should proactively assess

[67] *R v P & O European Ferries (Dover) Ltd*. (1991).

potential risk was discussed during the joint case of *R v Tangerine and R v Viola*[68] (2011). The UK's Court of Appeal decided that corporate liability should not be based on what management knew but what they ought to have known. The Challenger launch decision (NASA, 1986) and the explosion of the Deepwater Horizon (National Commission, 2011) are examples of how safety critical decision-making can incrementally drift towards compromise unless culture is actively and positively managed.

3.6 Defining the Attributes of d3SC

3.6.1 Overview

For the model to progress towards a practical tool of corporate risk management, further and broader definition was required of the nine linked attributes of d3SC described in *Figure 5*. These broader categories were referred to as the attributes of d3SC and it is these the quality of each of these attributes and their interrelationship which combine to represent a synoptic of the quality and nature of the organisation's safety culture. Leaving the attributes as narrow statements could force inappropriate interpretation of each category away from the context from which it was originally derived. Hofstede, (2001, 2011) mitigated the misinterpretation in his work by assigning quasi-words and codes to each cultural characteristic. Following Hofstede, the nine attributes were assigned their own three letter code or quasi-word and given more expansive definitions based on the themes identified during the theoretical coding process.

Further comparative analysis was made with the case studies and the associated theory. The broader definitions of the attributes also provided richer causal explanation of the complex relationships within organisations and mitigated any positivist tendencies for the attributes to become overly abstract (Martin, 2001). Utilising this method, the definitions combined safety culture characteristics and elements of liability for corporate manslaughter and provided a data structure of nine values to enable further development of a theoretical model. A description of each of the nine attributes now follows.

[68] *R v Tangerine Confectionery Limited* and *R v Veolia ES (UK) Limited* [2011] EWCA Crim 2015 were heard simultaneously by the Court of Appeal as both cases were concerned with the same area of law; the requisite level of foreseeability in risk assessment.

3.6.1.1 Wilful Blindness by Senior Management: WBL

This value relates to whether senior management in this organisation, demonstrate an authentic commitment to safety. Pinto & Evans (2008) emphasise that the 'wilful blindness' of senior management towards issues of safety and risk management is highly detrimental towards an effective safety culture and is an organisational attribute that is common to practically all jurisdictions in their corporate prosecutorial policies. The CMCHA requires that to establish liability under the Act, senior management must have contributed to the accident and that contribution must be more than de Minimis[69]. According to research by *inter alia* Leveson, (2004, 2011a, 2011b), Flin (2007), Hollnagel (2014) and Hopkins, (2014a) the single biggest influence on the quality of organisational safety performance is the level of commitment to safety and safety culture demonstrated by management.

3.6.1.2 Risks Managed as Low as Reasonably Practicable: LRP

Many organisations claim within their policy documents and senior management statements to have reduced their risks to be as low as reasonably practicable (ALARP). Highlighted by Lord Justice Cullen in the enquiry into the explosion of the Piper Alpha oil platform in 1988, (see *Table 3-1*), the legal system requires organisations to collectively assess all risks to society produced by an organisation. According to David & Wilkinson, (2009) it is a common error for companies to de-construct their total risk exposure to society. Each individual risk group can then appear to be managed to an acceptable level. This value assesses whether the organisation addresses its risk management practices to an authentic, and therefore defendable, standard fatal accident should the organisation be associated with a fatal accident. The two recent cases of R v *Tangerine and R v Veolia* determined to what extent employers had to project their risk management policy. The presiding judge, Lord Justice Hughes commented that risks are not limited to those which are obvious, "They impose, in effect, a duty on employers to think about things which are not obvious".

[69] See Wells (2010) in Law Commission's report 195 at page 14: "It will not be necessary for the management failure to have been the sole cause of death. The prosecution will, however need to show that "but for" the management failure (including the substantial element attributable to senior management), the death would not have occurred".

3.6.1.3 Employee Attitudes Compatible with Corporate Policy: EAC

This value assesses the extent to which senior management effectively promote their espoused values of safety and risk management through to their management practices and subsequently to their operational personnel. Professor Celia Wells (2001, 2010) emphasises that a company cannot escape liability by assuming that employees are error-free, (this point was further emphasised in *R v Tangerine and R v Veolia*). To defend themselves, a company must be able to demonstrate that appropriate defences and risk mitigation must be in place. These safety measures must be effectively communicated to staff. The extent to which safety and risk activities are compatible with organisational policy is determined primarily by employee attitudes and not by company policy statements.

3.6.1.4 Common and Accepted Practices that Compromise Safety: CAP

Organisational learning of standards of operation is crucial for safety and risk management and from a potential liability perspective. Hudson (2007), Brooks, (2008) and von Thaden & Gibbons (2008) noted that the emergence of sub-cultures within an organisation is often the precursor to rule violations and deviations away from safe practice. This value assesses how effectively common and accepted practices which incur inappropriate risks are identified and challenged. Gobert & Punch (2003) emphasised that a jury will look to actual examples of how safety and risk are managed within a company rather than perfunctory policy statements about high standards of safety. Hopkins, (2014a), noted the reporting structure on the Deepwater Horizon was restricted to the on-site managers rather than creating a direct line of communication to corporate safety management.

3.6.1.5 Acceptable Levels of Safety: ALS

Middle managers are constantly balancing production pressure and system risk to an acceptable level. This role has been described by Hollnagel (2014) as efficiency thoroughness trade-offs. In the event of a fatal accident the level of acceptability adjusts to the precision of hindsight. Bell, Glade, & Danscheid (2006), describe how safety and risk managers commonly and mistakenly associate standards that are imposed by regulatory minimum as an adequate defence to any issues of liability. This value, commonly referred to as ALOS, assesses the extent to which safety and risk practices are

driven by alternative, equivalent or minimum levels of safety compliance rather than justifiable or socially acceptable standards of risk. This is not ALARP, as defined by *Edwards v National Coal Board* [1949][70] and does not constitute the basis of a corporate defence. If an organisation is involved in a multi-fatality accident, the corporate body has to take responsibility for employees that make mistakes. In *R v Tangerine and R v Veolia*[71], as human error is a foreseeable risk factor it has to have been considered and mitigated for.

3.6.1.6 Credible Efforts to Improve Safety Culture: ISC

This value assesses employee attitudes to organisational efforts to improve safety culture. In the investigations into the BP explosion at Texas City and the explosion of the Deepwater Horizon, the lack of understanding of the differences in process and system safety were highlighted by both the Baker Report and the President's inquiry. Criminal sanction is generally seen as a last resort with the intent of deterring poor practice and incentivising the development of resilient safety and risk practices. Commented on in the sentencing remarks of *R v Lion Steel* by Judge Gibart QC, the risks to an organisation through the threat of criminal sanction may be mitigated by demonstrating that credible efforts have been made to improve safety culture. In the case of *R v Lion Steel*, the company compounded their liability by having ignored previous recommendations to improve safety standards by the HSE and improvements to their risk process recommended by their own insurance company.

3.6.1.7 Management Encouragement of Excessive Risk Taking: MXR

This value is linked to an organisation's policies or practices that provide incentives to company staff to engage in excessive risk practices. If these practices are implicated in a fatal accident, then the organisation does not possess an effective safety culture. These phenomena directly link senior managerial action with accident causation, (Hopkins & Maslen, 2015). As an example, prior to the explosion that occurred in the Westray mining disaster (see *Table 3-1*), employees who reported and complained about the practice of using torches in a mine shaft known to contain combustible materials were disciplined.

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[70] 1 ALL E.R. 743.
[71] See *supra* note 68.

3.6.1.8 Staff Breaking Rules or Working Around Procedures: SBR

Grote *et al* (2004), determined that even compared with other complex and highly regulated industries (e.g. healthcare) aviation was heavily rule dependent. Coupled with senior and middle management attitudes and practices towards safety and risk management, this value may demonstrate employees are actively exposing the organisation to administrative penalties, or potentially criminal sanction. Breaking rules and procedures is increasingly viewed in the context of organisational behaviours and norms, in effect, the quality of its safety culture. However, this attribute is strongly linked to ALS and how varying degrees of tight coupling in rule application must be considered in context rather than simply if rules or SOPs are adhered to, (Grote, 2007).

3.6.1.9 Excessive Risk Taking Discouraged by Management: XRD

This value differentiates between excessive or unjustifiable risk practices, resulting from senior management' other peripheral cultural influences such as organisational, professional or ethnic cultural traits. Managerial responsibility extends to these practices and therefore positive discouragement of egregious behaviours and efforts to reduce excessive risk activities may mitigate corporate culpability. In *R v MNS Mining Ltd* [2014] the company was acquitted of charges under the CMCHA following the deaths of four miners[72]. The responsible manager Malcolm Fyfield had carried out further checks than was required by regulation. This was seen by the court as indicative actions of a credible company safety culture. The jury were directed that the company could not be considered guilty under the CMCHA unless they had considered the wording under section 8(3) of the Act, that is, "the extent to which the evidence shows that there were attitudes, policies, systems or accepted practices within the organisation that were likely to have encouraged any such failure...or to have produced tolerance of it".

3.6.2 The Temporal Element

Todd Conklin's (2012) book asks his readers to develop an organisational mind-set which considers potential accidents rather than simply waiting for the next. Fraher (2014), also highlights the antecedents of 'the next aviation accident', in the risk management

[72] Unreported case. On the 15th September 2011 four miners at Gleision Colliery in the Swansea valley, South Wales were killed following a sudden inrush of water into a mine during blasting operations.

strategies contemporary airlines in the United states. The issue of temporal perspective is an important consideration in determining accident causation and therefore influences investigation outcomes and perspectives of legal liability. Hollnagel (2014), promotes the enhancement of next generation or pro-active approaches to safety management termed 'Safety II'. The approach is designed to encourage resilience in safety management by focussing attitudes on learning from reporting and safety discussion rather than the more traditional retrospective learning.

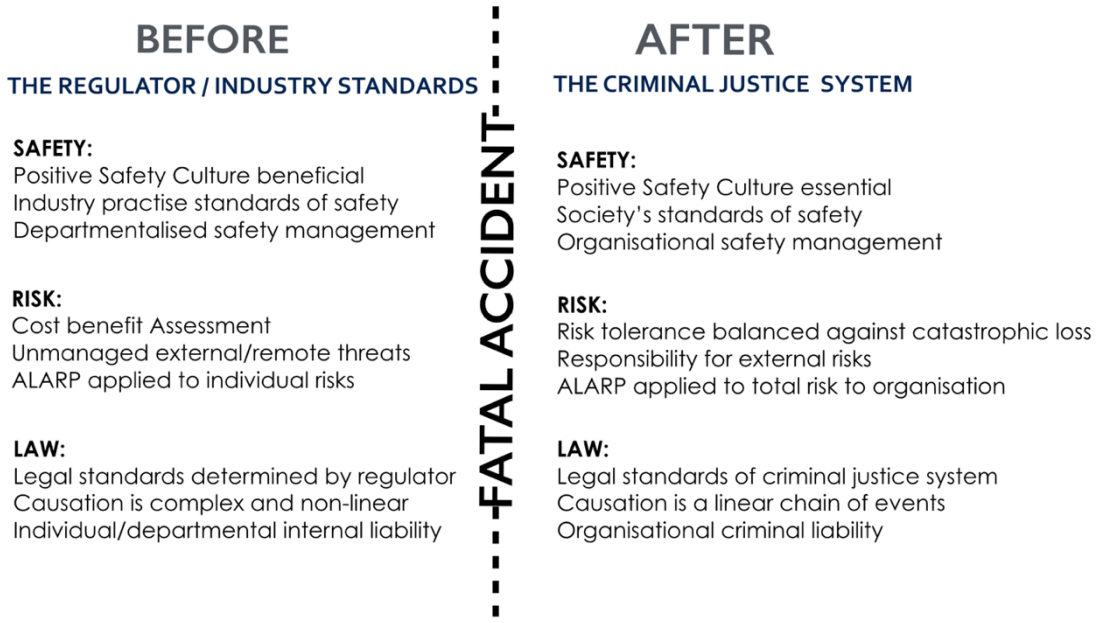

Figure 6 The changing temporal perspectives of a fatal accident.

Figure 6 gives examples of how the liability status of an organisation can alter before and after a theoretic fatal accident. The areas of investigation are split into three broad categories of safety investigation, risk management and legal liability. The left-hand column describes how before any incident, norms of safety, risk and law are perceived. Safety culture is held to be a positive desirable feature of the safety management system, companies will tend to follow industry norms in terms of standard or evolved practice (Reason, 1997; Townsend, 2016; Hollnagel, 2014). Safety is a department within the organisation rather than a corporate objective with appropriate incentives for solving risk targets, (Hopkins & Maslen, 2015). After the fact, safety culture is described as an essential but absent barrier to organisational failure. Safety standards determined by public perceptions of risk are applied and the whole of the organisation becomes

embroiled in the totality of corporate responsibility, (Wells, 1996, 2001; Almond, 2013). The three causal pathways of d3SC described as direct, influenced and inferred broadly relate to three levels of organisational culpability. In representing a defence of due diligence, the d3SC model had to differentiate between not just the negative causal pathways but indicate positive direction. Ostensibly in a real-world scenario a risk manager wishes to know whether the quality of the safety culture in the organisation they represent is sufficiently robust to rebuff a corporate manslaughter prosecution in the event of a fatal accident. Unlike private law, criminal lawyers rarely provide prophylactic counsel; that is a perceived realm of the regulator. However, the regulatory role tends to be to manage rather than enforce (Almond, 2015). Potential criminal liability has to be considered retrospectively, that is, as if the fatal accident had already occurred.

3.6.3 Potential Corporate Liability

Although a multi-national industry with considerable international commonality, legacy aviation companies are often brand-tied to their national associations. The multi-jurisdictional nature of commercial aviation cannot be entirely set aside, and as such, the development of this initial theory is primarily focussed on the pillars of national law. The relevance of safety culture is based on Anglo-American legal concepts, particularly those concerning corporate manslaughter. This does not mean the influence of progressive associations of corporate exposure are wholly limited to domestic liability. It is increasingly common for domestic courts to consider directive influences from other jurisdictions. This is particularly the case for multi-national industries in issues of ethics, conduct and industry best practice, (Forlin & Smail, 2014; Herber, 2014; Pearson & Riley, 2015). The link between corporate manslaughter and corporate safety culture has been identified by Reason (1997), Johnson (2008), Dekker (2007, 2011) but there has been minimal progress in developing consensus into practical risk management processes. Michaelides-Mateou & Mateou (2010), suggested the practice of 'legal defence strategy management' was a cynical and undesirable tactic by corporations, but they did not specify how or why that was the case.

A legal standard of safety culture has to also consider regulatory recommended standards, even though they are considered best practice rather than mandates. However, the legal standards set by the criminal justice system are significantly more difficult to establish

but must be considered given the gravitas of the process, the magnitude of penalty and public relations impact on any organisation. Given the rising profile of corporate criminal liability, the fluid nature of legal causation, and the emerging link between an organisation's safety related conduct and accident causation, significant latitude is granted to a corporate criminal prosecutor. The linking of organisational conduct with an organisational accident, is a significant risk to any company in a safety critical industry that has not treated safety as an appropriate corporate goal. The changing nature of corporate bodies in structure, perception and legal liability suggest that their exposure to risk should be reassessed. Consideration should be given not only to loss of human life, physical damage, environmental impact and financial aspects of organisational accidents but the increased potential in criminal legal liability to terminate the organisation and/or incarcerate members of its workforce.

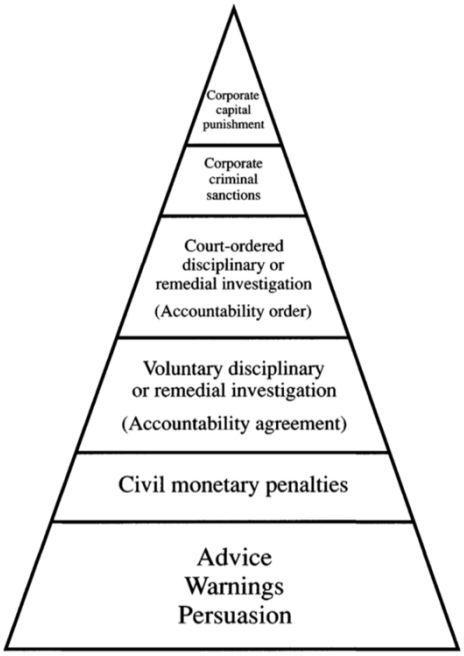

Figure 7 Fisse & Braithwaite, (1993:142): Pyramid of Disciplinary and Remedial Intervention for Corporate Offenders.

Fisse & Braithwaite (1993) contributed to a significant phase of work which considered corporate accountability in the wake of the Enron scandal[73]. The financial regulatory community faced considerable criticism for what was determined in hindsight to be lax regulatory practice. Their model suggests six increasing layers of enforcement beginning with persuasive methods and enhancing the gravity of sanction to that which would terminate the corporation's ability to operate. They suggested that for the middle-class management community they need to influence, much of their egregious financial activities would be deterred by the threatened sanction of publicity. Their pyramid model seen in *Figure 7* works on the principle that lower levels of sanction become more effective if the corporate actors or agencies were certain that higher level sanction was waiting for them in case of

[73] The $63.4 Billion bankruptcy of the Houston based energy company, Enron Corporation in 2001 is considered the largest in United States legal history. The failure of Arthur Anderson Plc, to adequately audit Enron caused the collapse of the firm; at the time one of the worlds five largest accountancy firms.

non-compliance. If we adapt the pyramid to the legal framework of commercial aviation, it is worth considering how a legal standard of safety culture could be enforced. As the regulatory and criminal law stands in most jurisdictions, a legal standard of safety culture is effectively absent in all but the higher echelons of the pyramid. That is of course only currently valid in those jurisdictions such as the United Kingdom, Canada and Australia that have begun to recognise corporate liability that is based on the doctrine of aggregation.

3.6.4 A Model of Potential Corporate Liability

Townsend (2016) notes the pressure that regulatory agencies have come under to increase their enforcement activity. He notes that the HSE have consistently increased the annual number of prosecutions year on year and have now developed their own enforcement management model. This was enhanced by the enactment of the Regulation and Enforcement Act 2008, (RESA) sought to rationalise local government enforcement action as there were inconsistencies in prosecution standards.

LIABILITY	COMPLIANCE ENFORCEMENT (Adapted from Fisse & Braithwaite's Accountability Model, pre-CMCHA)	Potential Enforcement Action (UK Aviation)
Corporate Criminal Liability LEVEL 6	Escalated criminal liability (individual & corporate) Jail for individual offenders; heavy financial penalties for the corporation and adverse publicity orders.	Corporate Manslaughter (CMCHA) Gross Negligence Manslaughter Health & Safety Prosecution
Corporate Criminal Liability LEVEL 5	Criminal liability (individual & corporate) Community orders, probation and fines for individuals. Fines, adverse publicity orders and probation for corporations.	Corporate Manslaughter (CMCHA) Health & Safety Prosecution CAA Act 2012 Prosecution
Corporate Criminal Liability LEVEL 4	Court ordered remedial investigation. Assurance order including a program of disciplinary or remedial action.	Corporate Manslaughter (CMCHA) CAA Act 2012 Action:Fines & Publication Compliance/Stop/Restoration Notices
Corporate Liability LEVEL 3	Investigation by regulatory authority. Court approved remedial order: disciplinary or remedial action (potential publication of remedial action by regulator).	CAA Act 2012 Action: Compliance/Stop/Restoration/Enforcement Notices Potential Publication
Corporate Liability LEVEL 2	Fines imposed by regulator/civil courts. (potential publication of remedial action by regulator).	CAA Act 2012 Action: Under RESA 2008 Potential Publication
Corporate Liability LEVEL 1	Warnings, advice, persuasion or any other form of informal methods to encourage compliance.	Guidance / Advice / Verbal Warning

Figure 8 A Combination of Fisse & Braithwaite's Model with UK Aviation Criminal Law and Regulation.

The sheer scale and complexity of Health and Safety regulation had created uncertainty for businesses as to what the requisite standards were over a broad array of Health and

Safety regulation (Löfstedt, (2011). The United Kingdom's CAA enhanced their own enforcement policy under the Civil Aviation Act 2012. The strategy was similar in the logic of gradual enhancing penalty used in Fisse & Braithwaite's (1993) enforcement pyramid. Recognising the sensitivity that corporate actors that operate in the commercial aviation sector have over corporate branding and corporate safety compliance issues, the 2012 Act can invoke a publicity order as an early sanction. The model in *Figure 8* aligns the CAA 2012 Act with current UK legislation on Corporate Manslaughter over six scales of Potential Corporate Liability (PCL).

3.6.5 A Prototype d3SC Model

The broader definitions of hierarchy causal relationships and potential outcome could now be represented in a diagram as depicted in *Figure 9*. The flow of these relationships runs from top left (WBL) down and to the right, emphasising the strong significance of senior management commitment to safety culture and in turn influencing the more symptomatic characteristics along the bottom row.

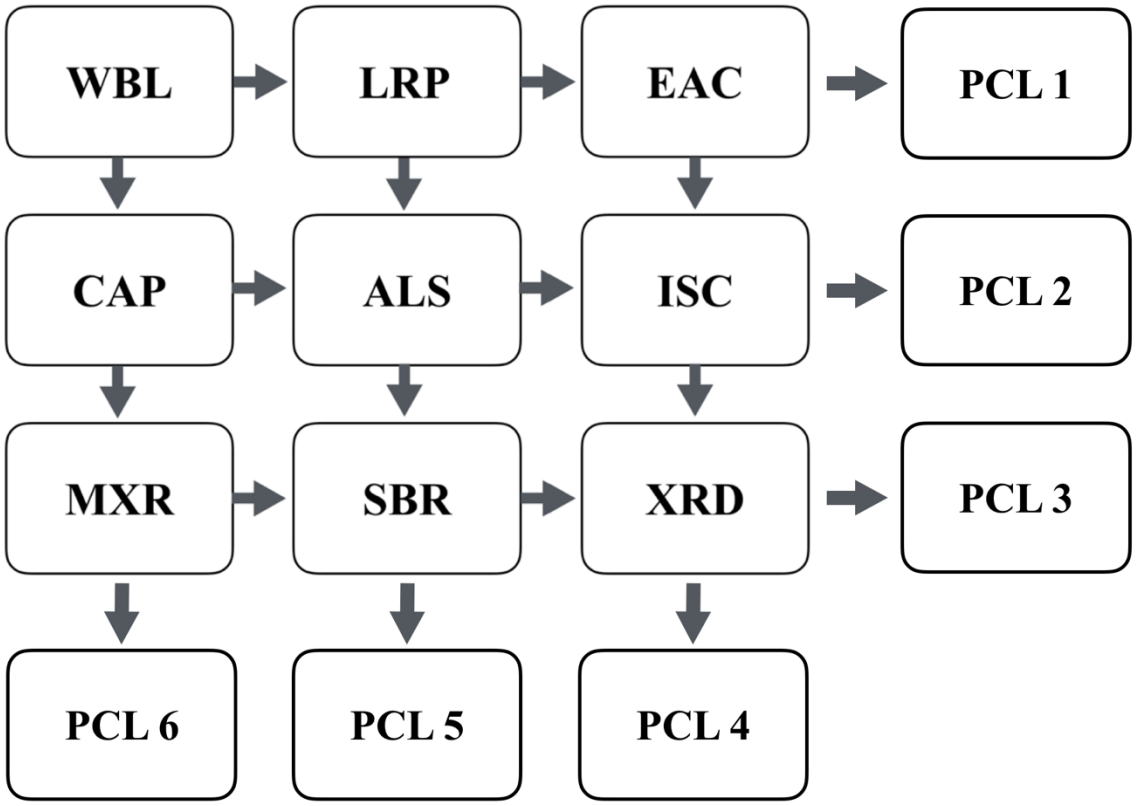

Figure 9 A Prototype Model of d3SC Describing the Interrelationships Between the Attributes and PCL – Potential Corporate Liability.

The PCL (Potential Corporate Liability) levels run from one to six as explained in *Figure 8*. PCL 1 is the lowest level of culpability and represents a probable outcome of guidance, advice or verbal warning. PCL levels of 1 through to 3 are probably within the realm of civil liability and possible regulatory penalty which can be insured against. The levels increase in severity of consequence up to PCL 4 through to 6 may well result in a prosecution under the CMCHA. For social policy reasons, virtually all jurisdictions forbid insurance policies from covering any criminal penalties (Pearson & Riley, 2015).

3.7 Discussion

This study has highlighted how elements of safety culture have been translated into a legal concept of causation in numerous case studies. This legal potency is perhaps accentuated by the lack of a clear definition or cohesive strategy that would facilitate conventional regulatory techniques. As noted in the literature review, despite the considerable body of research linking effective safety cultures to positive safety performance regulatory progress has been limited. In contrast, the global trend in corporate criminalisation has embraced safety culture as a malleable descriptor of organisational culpability (Wells, 2010; von Hirsch, 2014; Almond, 2015). The experiences of progressive efforts in the Norwegian oil and gas industry, (Le Coze & Wiig, 2013) and the nuclear industry, (Wahlstrom & Rollenhagen, 2009), suggest that pushing forward well-meaning regulatory efforts to promote safety culture may be counter-productive to safety performance. However, procrastination or deliberate inactivity by regulatory bodies, would leave commercial aviation open to the continual onset of corporate criminalisation. The impact of the latter is uncertain, but it is unlikely to promote the necessary open reporting systems that lie at the heart of successful safety management.

In complex systems, such as commercial aviation, cause and effect are neither proportionate nor intuitive, (Hollnagel, 2014). In contrast, there are deep socio-psychological needs which continually try to make them appear so. The struggle between these perspectives, essentially map the fundamentals of social policy discussions on concerning acceptable levels of safety and risk management. Jurisprudence, cannot simply be taken singularly from an interpretative view of law and dismissed as illogical or irrelevant to safety. At least some elements of legal positivism have to be considered

insofar as they are predominantly deliberate strategies that have to accommodate the conflicting priorities and limited resources all society. The net effect of this on commercial aviation is that the massive impact of fatal accidents cannot be exempt from the influence of criminal justice systems.

As the criminal justice system has to continually evolve to represent the values and attitudes of the society in which it operates, it has to absorb emerging causational concepts that explain individual and corporate behaviours. The data in *Tables 3-3 and 3-4* describe a picture where safety culture would appear to be a developing, not just as a mechanism to manage safety related values and attitudes within organisations, but also as a legal concept that associates accidents with corporate criminal liability. Designers of future regulatory strategies of implementing safety culture, may question the necessity of enforcing internationally homogenous models of safety culture within jurisdictions that have existing and explicit policies of corporate criminal liability. Operating organisations could be compelled by their own enterprise risk strategy to assess whether their particular safety culture is sufficiently aligned with the cultural values, norms and acceptable levels of risk that are enshrined within their own legal system.

3.8 Conclusion

The aim of this study was to develop a prototype d3SC model through the identification and comparison of attributes of legal causation identified in accident reports that have been associated with safety culture. The physical and temporal proximity of operators and their supervisors has traditionally provided the obvious target for retributively driven prosecution, however the examples cited in the *Tables 3-1 and 3-2* would suggest that that the prosecutorial target is moving from individuals towards an association with corporate culture. This change is prosecutorial focus is reflected in broader legal discourse (Donaldson & Watters, 2008: Wells, 2010; Almond, 2015) however there is a significant lag in the development of mechanisms with which organisations can understand and manage the causal role of safety culture. The development of leading indicators of the attributes of safety culture comprising d3SC, that could impute corporate criminal liability, are worthy of further research. Identifying and managing them could be an effective strategy to avoid the more damaging effects of criminalisation and a powerful incentive towards the building of resilient safety cultures within commercial aviation.

Table 3-1 The Causal role of Safety Culture in a number of High Profile Accidents

Incident, Year & Fatalities	Inquiry	Synoptic of the Causal Role of Safety Culture	Individual Criminal Prosecution/ Conviction	Corporate Criminal Prosecution/ Conviction
Chernobyl Nuclear Reactor Meltdown 1986: Approximately 60 initial deaths.	IAEA (International Atomic Energy Agency), Safety Series INSAG-7 (1992).	'…safety culture was lacking in the operating regime at Chernobyl', (IAEA, 1992:21)	Six site managers & supervisors were convicted & sentenced under the Criminal Code of Ukraine, with terms of between 2 & 10 years on labour camps, *Marples, (2014).*	None
Challenger Space Shuttle Launch Accident, 1986: 7 Fatalities.	Report by the Presidential Commission, chaired by William P. Rogers, (NASA, 1986)	Commissioner Richard Fenyman described NASA's organisational decision making as 'a kind of Russian Roulette', (NASA, 1986:148)	None	None
Sinking of the Herald of Free Enterprise, 1987: 193 Fatalities.	Department of Transport, (1987). Inquiry headed by Mr. Justice Sheen.	'From top to bottom the body corporate was infected with the disease of sloppiness', (Dept. of Transport, 1987:14).	The Crown, on the grounds of insufficient evidence, dropped five individual prosecutions for manslaughter. *R v P & O European Ferries (Dover) Ltd*. (1991).	The case against the company failed when Turner LJ directed the jury not to convict. *R v P & O European Ferries (Dover) Ltd*. (1991).
Kings Cross Underground Fire, 1987: 31 Fatalities.	Department of Transport (1988). Inquiry headed by Mr. Desmond Fennel QC.	'…London Underground at its highest levels may not have given as high a priority to passenger safety in stations as it should have done', (Dept. of Transport, 1988:116).	None	None
Explosion of the Piper Alpha Oil Rig, 1988: 167 Fatalities.	Public Inquiry into the Piper Alpha Disaster, 1990. Inquiry Headed by Lord William Cullen.	'Senior management were too easily satisfied that the (permit to work) system was being operated correctly, relying on the absence of any feedback of problems as indicating that all was well.' (Cullen, 1990:238).	None	None
Clapham Rail Crash, 1988: 35 Fatalities.	Investigation into the Clapham Junction Railway Accident 1989. Inquiry headed by Anthony Hidden QC	'There were obvious weaknesses both in the adequate training of staff and communicating to them, the force, relevance, and the importance of Departmental Instructions. Though they should have been obvious, the weakness were neither monitored nor corrected', (Hidden 1989:100).	None	British Rail pleaded guilty to two breaches of Health & Safety offences and fined £250,000. *R v British Rail Board* (1991), unreported, Central Criminal Court.

Incident, Year & Fatalities	Inquiry	Synoptic of the Causal Role of Safety Culture	Individual Criminal Prosecution/ Conviction	Corporate Criminal Prosecution/ Conviction
The Westray Mining Explosion, Novia Scotia, 1992: 26 Fatalities	'The Westray Story: A Predictable Path to Disaster: Report of the Westray Mine Public Inquiry', Richards, (1996).	'The unsafe use of torches underground was a common practice at Westray. Management was aware of the practice, condoned the practice, and reprimanded those who condemned it. In so doing, management sent a clear message to the underground workers. Management's unsafe mentality was, in effect, filtering down to the Westray workforce', Richard, (1997:149)	Two charges of manslaughter were imposed on two of the mines managers, Gerald Phillips and Roger Parry, but were stayed by the crown due to lack of evidence. Richards, (1996).	Public pressure following the disaster resulted an amendment to the Canadian Criminal Code 467.3 §.2(c). The amendment facilitates the prosecution of Board members, senior managers & the corporate body itself. Canadian Government, (1994).
Ladbroke Grove Rail Crash, 1999: 31 Fatalities.	The Ladbroke Grove Rail Inquiry. Rt Hon Lord Cullen, 2001.	"The culture of the place had gone seriously adrift over many years", Railtrack's incoming Zone Director, (Cullen, 2001:4).	None	Network Rail pleaded guilty to breaches of Health & Safety offences and fined £4 million. *R v Network Rail (2007)*, unreported, Blackfriars Crown Court.
Hatfield Rail Crash, 2000: 4 Fatalities.	Office of Rail & Road (ORR), 2006.	'At the time of the derailment and over the previous two years, the culture within Railtrack which conditioned decision making on safety and performance issues, was biased towards performance-driven decisions.' (ORR, 2006:8.105)	Fifty-five suspects were initially interviewed under caution. Six individuals were prosecuted for manslaughter and a further six under Health & Safety legislation. All manslaughter and Health & Safety charges were subsequently dropped against company executives. R v Network Rail, Balfour Beatty Rail Infrastructure Services Ltd and others, Old Bailey, 2005.	For Health & Safety Offences Balfour Beatty were fined £10 million (reduced to £7.5 million on appeal) & Network Rail (now taken over by Railtrack) fined £3.5 million. R v Balfour Beatty Rail Infrastructure Services Ltd. [2007] 1 Bus LR 77.
Columbia Space Shuttle in-flight break-up, 2003: 7 Fatalities.	Columbia Accident Investigation Board, (CAIB) 2003. National Aeronautic & Space Administration, (NASA).	'The Shuttle Program's complex structure erected barriers to effective communication and its safety culture no longer asks enough hard questions about risk.' (CAIB:185).	None	None
Loss of Nimrod XV230 in Afghanistan, 2006: 14 Fatalities	The Nimrod Review, Charles Haddon-Cave, 2009.	'…a safety culture that has allowed 'business' to eclipse Airworthiness', (Haddon-Cave, 2009:445).	None	None

Incident, Year & Fatalities	Inquiry	Synoptic of the Causal Role of Safety Culture	Individual Criminal Prosecution/ Conviction	Corporate Criminal Prosecution/ Conviction
Explosion of the BP Deepwater Horizon Oil Rig, 2010: 11 Fatalities.	'Deepwater: The Gulf Oil Disaster and the Future of Offshore Drilling', *National Commission*, 2011.	BPs own investigation report, does not mention the term 'safety culture' but focuses on the technical and human failings of the BP and Transocean rig teams. The National Commissions report mentions BPs poor 'safety culture' 25 times. 'BP's safety culture failed on the night of April 20, 2010, as reflected in the actions of BP personnel on and offshore and in the actions of BP's contractors', *National Commission*, 2011:223).	Two of the most senior managers on board the Deepwater Horizon at the time of the explosion, Donald Vadrine and Robert Kaluza, faced 11 counts of involuntary manslaughter, The charges were dropped in 2015, (*Dept. of Justice*, 2015).	In January 2013, BP accepted a guilty plea under §1115 of the US Criminal Code for *inter alia* Felony Manslaughter and fined $4 Billion. Further litigation costs of $18 Billion may mean the total cost of litigation could rise to $46 Billion. (*Dept. of Justice*, 2013).
Meltdown of the Fukushima Nuclear Reactor, 2011: 0 Fatalities from immediate and direct radiation exposure.	The Official Report of the National Diet of Japan, 'Fukishima Nuclear Accident Independent Investigation Commission, (Executive Summary), 2012. Inquiry headed by Dr. Kiyoshi Kurokawa.	'Muto (Advisor and senior executive of the Tokyo Electric Power Company – TEPCO), implied that the cause of the accident was due to the unexpected tsunami, but the possibility of a tsunami was estimated in 2002—so TEPCO must have recognized the risks. Muto, however, claimed to have been unaware of such studies. This obviously was a failure of the safety culture within TEPCO', (Kurokawa, 2012:74).	Initially, the Fukushima Prosecutors Office had refused to prosecute thirty-three individuals under the offence of 'Professional Negligence resulting in bodily harm or death', (Japanese Criminal Code art. 211 (1), punishable by up to 5 years' imprisonment, or a fine of less than ¥1.000,000). The ex-Chairman of TEPCO and 2 senior executives face criminal charges. An investigation will determine whether the case will proceed to trial, Herber (2014).	There is no general Corporate liability under the Japanese Criminal Code, although under the doctrine of Ryobatsu-Kitei (double punishment) a corporation could face charges for the act of an associated individual. (Donaldson & Watters; 2008, Forlin & Smail; 2014).

Table 3-2 The Causal role of Safety Culture in Commercial Aviation Accidents

Incident, Year & Fatalities	Inquiry	The Causal Role of Safety Culture	Individual Criminal Prosecution/Conviction	Corporate Criminal Prosecution/ Conviction
Air Inter Flight 148, Strasbourg, 1992: 87 Fatalities.	Rapport de la commission d'enquête sur l'accident survenu le 20 janvier 1992 près du Mont Sainte-Odile (Bas Rhin) à l'Airbus A 320 immatriculé F-GGED exploité par la compagnie Air Inter, BEA (1993).	'The Commission therefore considers that the company culture is an important component of understanding the negative position taken by the company in respect of the GPWS'. BEA, (1993:23.113).	Six individual defendants from Airbus, air traffic control, the airline, and the French Aviation Authority, DGAC were prosecuted then acquitted of manslaughter charges, Pearson, (2015).	Airbus and Air France (parent of Air Inter) liable for damages and ordered Air France and Airbus to pay compensation to the relatives of the deceased', Tribunal de Grande Instance de Colmar, (2006).
ValuJet Flight 562, Florida 1996, 110 Fatalities.	'Aircraft Accident Report NTSB/AAR-97/06(PB97-910406), In Flight Fire and impact with Terrain, ValuJet Airlines Flight 592, DC-9-32, N904VJ Everglades, near Miami, Florida, May 11, 1996', NTSB (1997).	In a letter from ValuJet's Federal Aviation Authority inspectors: 'It appears that ValuJet does not have a structure in place to handle your rapid growth, and that you may have an organizational culture that is in conflict with operating to the highest possible degree of safety.' NTSB (1997:77).	Sabre Tech vice president of maintenance & two mechanics were charged with recklessness and numerous regulatory breaches. In 1999 all individuals were acquitted. US v Sabre Tech (2001).	Sabre Tech was found guilty of several regulatory & safety breaches. The convictions were eventually over-turned by the Federal Appeals Court. The company was also charged by Florida state prosecutors with 110 counts of 3rd degree murder & 110 counts of manslaughter. All but one of the charges were dropped under a plea agreement, Pearson, (2015).
Alaska Airlines Flight 261, California, 2000: 88 Fatalities	'Loss of Control and Impact with Pacific Ocean Alaska Airlines Flight 261 McDonnell Douglas MD-83, N963AS About 2.7 Miles North of Anacapa Island, California January 31, 2000' NTSB (2000)	An NTSB Safety Assessment carried out earlier in 2000 made 170 recommendations it stated were intended to "guide both strategic planning and tactical action by Alaska Airlines as they move to strengthen the foundation of an effective safety culture that anticipates the potential for problems and acts swiftly and effectively to mitigate such threats." NTSB (2002)	None	Following the NTSB report into the crash, the US Attorney's Office announced a criminal investigation into the conduct of Alaska Air Group Inc. The case was dropped due to lack of evidence in 2003. US Attorney's Office (2003)

Incident, Year & Fatalities	Inquiry	The Causal Role of Safety Culture	Individual Criminal Prosecution/Conviction	Corporate Criminal Prosecution/ Conviction
Air France, AFR 4590, Concorde F-BTSC, Paris, 2000: 113 Fatalities.	'Accident on 25 July 2000 at La Patte d'Oie in Gonesse (95) to the Concorde registered F-BTSC operated by Air France', Bureau d'Enquêtes et d'Analyses Pour la sécurité de l'aviation civile, BEA, (2002).	The report mentions 57 incidents of tyre damage to Concorde aircraft. After implementing Airworthiness Directives during 1981-1982, no further modifications were made, suggesting the aircraft type was operated for over 17 years with a known risk to safety. The fleet incurred further incidents but the major design requirement, the strengthening of the fuel tanks was only undertaken after the fatal accident. BEA (2002:94-97).	Two former Concorde engineers, a former French civil aviation official and two Continental Airlines employees were charged with various offences including manslaughter. Initially only one employee of Continental was found guilty but in 2012 his sentence was overturned. Pearson, (2015).	Continental Airlines were initially charged and convicted of corporate manslaughter. The company was fined €200,000. This verdict was overturned in 2012, absolving Continental of any criminal responsibility. Pearson, (2015)
Collision of Scandinavian Airlines System Flight 686 with a Cessna Citation at the Linate Airport in Milan, 2001. 118 Fatalities	Agenzia Nationale Per La Sicurrezza Del Volo (ANSV): Accident involved aircraft Boeing MD-87, registration SE-DMA & Cessna 525-A, registration D-IEVX, Milano Linate airport, October 8, 2001, ANSV (2004).	Commenting on the lack of compliance of aerodrome management to Annex 14, the ICAO guide to aerodrome safety management: 'The reason for this may be many; complex aerodrome management organization, lack of safety management system, unclear responsibility structure, weak safety culture, high traffic flow/intensity and physical expansion of aerodromes, etc. ANSV(2004:152).	In 2004, a court convicted four defendants, including one air traffic controller and the former director of the Italian air traffic control agency (ENAV) of manslaughter and negligence and sentenced them to prison terms ranging from six and a half to eight years. Pearson, (2015).	Corporate criminal liability was not recognised in Italian law until 2001, namely Legislative Decrees 231/2001. This statutory liability does not extend to public bodies. Gobert & Mugnai (2002).
Crossair Flight LX 3597 Crossair Avro RJ100, Zurich, 2001: 10 Fatalities.	'Final Report No.1793 by the AAIB concerning the accident to the aircraft AVRO 146-RJ100, HB-IXM, operated by Crossair, Flight Number CRX 3597, 24th November 2001, Basserdorf, Zurich'. AAIB (2003).	'In summary, the flight safety officer described the activity of the flight safety department as reactive.' AAIB (2003:1.17.1.3). 'The individual fleets differed greatly in terms of their operation and operating cultures', AAIB (2003:1.17.14) Described as a 'culture of fear' by prosecutors, Michaelides-Mateou & Mateou (2010:74).	Six Crossair Chief Exeecutive, Dose, Chairman Maurice Sauter, four other airlines executives and the Chief of FOCA (Swiss Aviation Regulator), Andre Auer, faced criminal charges for negligent homicide. Their cases were eventually stayed in 2008. Pearson, (2015).	Corporate criminal liability can be invoked under Article 102 of the Swiss Penal Code; the wording of the article would suggest this is only as an alternative where individual liability cannot be imputed. (Donaldson & Watters; 2008, Forlin & Smail; 2014).
DHL B757 collision with Bashkrian Airlines Tu154, Uberlingen, 2002, 71 Fatalities	Investigation Report: (AX001-1-2/02). Accident, 1 July 2002, (near) Uberlingen/Lake of Constance/ Germany.Type of Aircraft: Transport Aircraft: Boeing 757-200,Tupolev TU154M. BFU, (2004).	'Organisational processes to create such a safety culture were also still under way. Being new the safety and risk management systems were still at the development stage. Their introduction was basically accepted by all management levels but adequate resources had not been provided.' BFU (2004:93).	Eight middle managers of the Swiss air traffic company, Skyguide, were prosecuted. Four were convicted under negligent homicide. Three were given suspended prison sentences and one was fined. Michaelides-Mateou & Mateou (2010).	See above relating to Swiss corporate criminal law.

Incident, Year & Fatalities	Inquiry	The Causal Role of Safety Culture	Individual Criminal Prosecution/Conviction	Corporate Criminal Prosecution/ Conviction
Platinum Jet, Challenger CL-600, Teterboro Airport in New Jersey, 2005. 0 Fatalities	'Accident Report on Runway Overrun and Collision Platinum Jet Management, LLC Bombardier Challenger CL-600-1A11, N370V, Teterboro, New Jersey, Feb. 5, 2005', NTSB (2006).	'Because neither Darby Aviation nor Platinum Jet Management (PJM) was rigorous about enforcing the Federal requirement for operational control, PJM pilots operated in an environment in which pilot errors and/or omissions during pre-flight preparations were less likely to be detected before departure.' NTSB (2006:63).	Michael & Paul Brassington, the owners of Platinum Jet were sentenced to 30 & 18 months respectively for falsifying FAA 'Part 135 certification' and aircraft load and balance paperwork. US Attorney's Office, District of New Jersey (2011).	None.
Helios Airways Flight HCY 522, Boeing 737-31S, near Athens: 2005. 121 Fatalities	Air Accident Investigation & Aviation Safety Board (AAIASB) Aircraft Accident Report, Helios Airways Flight HCY522, Boeing 737-31S, at Grammatiko, Hellas on 14th August 2005. AAIASB (2006)	'The inexplicable inconsistences in the actions that were or were not performed, the actions recorded, and the actions described as having been performed by Ground Engineer No. 1 on the morning of 14 August 2005 were considered by the Board to confirm the idea that the Operator was not effectively promoting and maintaining basic elements of safety in its culture.' AAIASB (2006:199).	Four Helios Airways senior executives faced manslaughter charges in Cyprus and Greece. The Cypriot Court found the defendants not guilty but the subsequent Athens High Court case dismissed the defendants appeal and upheld their sentence of 10 years imprisonment with an option to buy out their sentence for €80,000. Dempsey, (2010)	Helios Airways, (later re-named 'ajet'), was charged by Cypriot prosecutors with manslaughter along with its senior executives however the company was dissolved in 2006. Michaelides-Mateou & Mateou (2010:89).
Mid-air collision of a EMB-135 Legacy business jet and a GOL Airlines B737 8EH in Brazil: 2006. 154 Fatalities	Final Report A-OOX/CENIPA/2008, Occurrence: Aeronautical Accident, Aircraft Registration: PR-GTD & N600XL, 17th July 2007. Centro de Investgacåo e Prevencåo de Acidentes Aeronåuticos, CENIPA (2008).	'The performance of the N600XL crew had a direct relationship with the decisions and organizational processes adopted by the operator, on account of culture and attitudes of informality.' CENIPA (2008:265)	The Legacy pilots and three Brazilian air traffic controllers were charged with negligence and involuntary manslaughter. The pilots were acquitted in 2008, but that was overturned in 2010. In 2011 the pilots were sentenced to 4 years and 4 months but commuted the sentences to community service to be served in the U.S. Pearson, (2015).	Brazilian Law currently restricts corporate criminal liability to environmental and economic crimes. Almond (2013:52).
TAM Airlines Flight 3054 Sao Paolo Congonhas Airport, 2007 199 Fatalities	Final Report A-No. 67/CENIPA/2009, Occurrence: Aeronautical Accident, Aircraft Registration: PR-MBK Airbus A-320, 29th September 2006. Centro de Investgacåo e Prevencåo de Acidentes Aeronåuticos, CENIPA (2009).	'Another point refers to the differences between the formal culture of the organisation and the way it is perceived by a certain part of its crewmembers, something that denotes certain fragility in the managerial sphere, mainly in relation to the way the company transmits its values to the employees.' CENIPA, (2009:88).	Ten government and TAM officials were charged with involuntary manslaughter with potential jail sentences of up to 12 years. Michaelides-Mateou & Mateou (2010).	See above relating to Brazilian corporate criminal law.

Incident, Year & Fatalities	Inquiry	The Causal Role of Safety Culture	Individual Criminal Prosecution/Conviction	Corporate Criminal Prosecution/ Conviction
Spanair Flight 5022 accident at Madrid Barajas Airport: 2008 154 Fatalities	Report A-032/2008 Accident involving a McDonnell Douglas DC-9-82 (MD-82) aircraft, registration EC-HFP, operated by Spanair, at Madrid-Barajas Airport, on 20 August 2008, CIAIAC (2010).	'The fact that audits conducted by the company's Quality Department were ineffective in detecting these deficiencies indicates that either the audits were not properly conceived or that the way in which technical flight records were kept was not a concern, which proves that such a culture was accepted and shared within the organization', CIAIAC (2010:221).	The head of Spanair's maintenance department and a Spanair mechanic were charged with 154 crimes of manslaughter and 18 crimes of negligent injuries. The charges against the mechanics were subsequently dropped and blame for the accident was placed on the two deceased pilots. See Air Crash at Madrid, No. 2:10-ml-02135, Affidavit of Salvador-Coderch, D.E. No. 197, at 4.	Spain excludes corporate bodies from bearing direct responsibility for criminal responsibility. Criminal liability can only be imputed where the corporation acts as an accessory to an individual's criminal act. Almond (2013:56).
Loss of Air France 447, F-GZCP, South Atlantic, 2009: 298 Fatalities.	On the accident on 1st June 2009 to the Airbus A330-203 registered F-GZCP operated by Air France flight AF 447 Rio de Janeiro – Paris. BEA, (2012).	"With regard to human factors, the behaviour observed at the time of an event is often consistent with, or an extension of, a specific culture and work organisation." (BEA, 2012:101). Prior to any BEA report, Air France commissioned an independent safety review team tasked with an analysis of company culture. Although not made public, Air France have committed to implementing all of the report's recommendations, (Air France, 2011).	None	Air France has been indicted and faces possible charges of Corporate Manslaughter having been referred, in July 2014, to the criminal court, (Air France, 2014). Airbus Industrie has also been indicted with multiple counts of manslaughter, Forlin & Smail, (2014).

4 STUDY TWO –Developing and Testing d3SC

4.1 Introduction

The initial inductive methodology of Study One produced a prototype model d3SC through a process of grounded theory. The model aimed to bridge the gap left by the ambiguously defined concept of safety culture, one that has not achieved significant consensus in academic or regulatory circles. By drawing on the literature, case studies and theory of legal causation the d3SC model invokes principles of corporate criminal liability rather than placing total reliance on embryonic regulatory standards. The visual output of the model produces a map of a subject organisation's safety culture. The map intuitively describes how the various hierarchical strata of corporate bodies influence potential corporate liability. The assessment process is intended to lead the organisation towards targeted improvement initiative and in so doing, provides a common descriptive terminology through the interrelationship of the nine attributes of safety culture.

4.1.1 Aim of the Study

The aim of this pilot study is to develop and test an appropriate measurement system for the d3SC model. The objective is to determine whether it can efficiently and accurately represent the quality of an organisation's safety culture against the organisation's potential liability for corporate manslaughter. The balance between pursuing the conceptual overview in the positivist tradition and understanding the ethnographic nuances that drive behaviours has been extensively discussed in the literature. The emergent property of the prototype model of d3SC with its nine attributes aimed to provide a pragmatic compromise between a broad purposive approach and one immersed in contextual detail. The output metrics of d3SC had to accurately maintain this balance. To maintain the integrity of the model's grounding in data, the output metric needs to represent the complexity of the organisation it is trying to describe. The prototype model of d3SC attempts to represent elements of functionalist and interpretative perspectives in a graphic form and additionally it needs to provide an overall impression of an organisation's safety culture.

4.1.2 Context

d3SC is designed to incentivise improvements to safety cultures by giving visual feedback of various attributes of safety culture and relating them to potential corporate liability. The output of d3SC are six levels of PCL (Potential Corporate Liability) representing various levels of a legal defence of due diligence as determined by the safety culture data. The extent to which an organisation had acted with due diligence and whether it should be liable for the actions of its servants was extensively discussed in *Tesco Ltd v Nattrass*[74]. Viscount Dilhorne (stated at page 185), "Here the question is not whether the company is criminally liable and responsible for the act of a particular servant but whether it can escape from that liability by proving that it exercised all due diligence and took all reasonable precautions and that the commission of the offence was due to the act or omission of another person. That, in my view, is a very different question from that of a company's criminal responsibility for its servants' acts." Maintaining an effective safety culture is therefore akin to taking all reasonable precautions in law and forms the basis of a defence of due diligence.

4.1.3 Ethical Challenges

The sensitivity of the subject matter significantly influenced the methodological approach by significantly deterring potential participants from sharing their opinion of safety culture. Invariably the potential participants were employees of the potential subject organisation. This was accentuated by linking an organisation's safety culture with an attempted calculation of potential corporate criminal activity creates an automatic restriction on potential data collection. Sourcing appropriate data is an essential for any research and this programme had specific challenges of confidentiality. During research design, a request was made to a major European airline to engage in the research. The request was refused. Staff from another airline that had been bought and merged into a larger organisation were asked to consider participation. This organisation was chosen as issues of liability and brand reputation were unlikely to be an obstacle to open discussion. However, despite numerous e-mail requests, no former employees were willing to participate in the research.

[74] [1971] 2 All ER 127.

The CPS declined a formal written request to provide any data on how they aligned corporate culture with their charging standards under the CMCHA. The HSE had produced a safety culture assessment toolkit for the rail industry, however a succession of telephone conversations (requesting research data) revealed that a senior HSE executive believed the AAIB and the CAA had appropriate safety and risk management assessment processes in place for commercial aviation. This appears not to have been entirely accurate[75].

The CAA considered a request for the provision of redacted data from early safety culture surveys, however following repeated delays the programme is now postponed[76]. Following further enquires an aviation organisation agreed to participate in the research programme intending to use the data as part of an ongoing safety culture improvement programme. An appropriate strategy described in the results chapter was agreed to ensure appropriate levels of anonymity. This agreement included details of which research methods were appropriate and acceptable to both parties. A research design process was formulated to include testing, calibration and validation. The Cranfield University Research Ethics System (CURES) guidance was followed and a formal application to proceed was submitted and approved. A copy of the CURES application and approval can be found at Appendix B.

4.2 Methodology

4.2.1 Overview

The development of d3SC towards a functioning assessment tool required both qualitative and quantitative methodologies to be employed. The requirement towards scoring the attributes with significant amounts of data inputs that would be required to effectively assess organisations, steered the process towards a mixed methods research approach rather than pure qualitative processes. However, some of the vagaries of legal process do not align with the principles of social science research, in particular a reliance in quantitative methodology on statistical inference. The thesis aims to describe the

[75] During its investigation into the Shoreham Air Crash of August 2015, the AAIB consulted the HSE to consider the quality of risk assessment under taken by the CAA and its appointed representatives prior to the event. Appendix J of the report the HSE notes "…the risk assessment is not considered fit for purpose…" (AAIB ,2017:351).
[76] Information obtained during a telephone conversation with Sean Parker, Head of Safety Data, CAA on the 27th June 2017.

development and testing of a theory of the legal standards associated with safety culture. Whilst the study has not followed the traditional formats of legal discourse, a considerable proportion of research has investigated some of the purer doctrinal aspects of legal causation; the nature of the research topic should determine the choice of methodology, (Marshall, 1996; Strauss & Corbin, 1998; Ritchie, Lewis, Nicholls & Ormston, 2013). This issue had particular bearing when consideration was given to how to interpret the data as metrics of d3SC.

4.2.2 Likert Questionnaire

A common method of measuring safety culture is Likert questionnaires, (Gadd & Collins, 2002, Guldenmund, 2007). The Likert questionnaire is a popular methodology as researchers in this field are predominantly trying to accommodate the values and attitudes of large groups. The Likert questionnaire is an efficient means of collating opinions but is only a blunt instrument. The output of a questionnaire can only provide a generic indictor of an organisation as an aggregated whole. Guldenmund (2007) considers the technique as generally unsuccessful and notes that the data produced by the questionnaire is highly contextual. As such some outputs can vary considerably from the intentions of some of the participants. To benefit from the efficiencies afforded by a Likert questionnaire, the design of d3SC had to consider these limitations in order to mitigate many of these issues. As such, the design requirements included the ability to present the data in distinct groups such as the attributes rather than one generic output. Developing the ability to efficiently split and present the data into its source groups or hierarchy was considered another mitigation. The questions design also had to be considered. The questions had to determine issues of potential corporate liability as well as the quality of safety culture.

4.2.2.1 Sourcing the Questions

Two meetings held in 2013 at the UK CAA's offices in London and at Gatwick Airport were organised by the researcher to ascertain the likely shape of safety culture assessment in the UK. The meeting was initially intended to provide feedback from the CAA legal department as to the regulatory viability of the study and from the safety data department to establish the practicality of feeding safety culture data to benchmark the model. The meetings also produced an introduction to the more progressive approach of the Swiss

Federal Office of Civil Aviation (FOCA). FOCA allowed access to their questionnaire which had undergone initial trials as a safety culture assessment tool. The approach of FOCA aligned with the preferred approach identified by the literature review of describing and utilising safety culture as a functionalist abstraction. The FOCA safety culture tool is based on the work of Montijn & de Jong, (2007) and subsequently Piers *et al*, (2007). It assesses safety culture in six key performance areas, described in the literature review. The questionnaire was reviewed, and the questions were aligned with each of the nine attributes. Some of the questions seemed to have lost some precision in their translation from Dutch to English and were either removed or re-worded to provide more clarity. Not all questions were considered appropriate indicators of the attributes as they were not relevant to corporate liability.

4.2.2.2 Refining the Questions

In considering their suitability for a Likert questionnaire, the questions were assessed by a subject matter expert within the Safety and Accident Investigation Centre at Cranfield University. The individual was consulted as they had recently been involved in the development of safety culture assessment tool for IATA which utilised a Likert questionnaire. The question wording was adjusted where appropriate to enhance clarity and suitability in addressing each of the attribute groups. The questions also related to matters of legal liability so a legal expert in corporate liability was consulted to review how they interpreted the questions. Initially a grading process was undertaken to edit down the number of questions to make the process easier to use and more efficient. There is a limit to the number of questions that will exceed participant enthusiasm and engagement. However, following consultation the subject matter expert, legal expert and following Krosnick & Presser (2010), it was considered that maintaining fifty questions but varying their scoring value would better represent the complexities of culture and causation. The attributes were explained to the Queen's Counsel, who was then asked to score each of the questions in terms of their importance or impact to an organisation's potential liability. Each question was graded as an A, B or C. An 'A' question was considered crucial to the subject attribute, 'B' as highly significant and 'C' as significant or useful for clarification. Legal opinion was also given on the interrelationship of the attributes; the significance of senior management engagement in safety related issues was emphasised along with the importance of ALARP in risk processes.

4.2.2.3 Weighting the Questions

Following the feedback from a legal expert, a weighting system of the questions was brought into the scoring system. Initially an ordinal scale was adopted with maximum scores of A = 30, B = 20 and C = 10; this was considered sufficient spacing to adapt to further calibration. The attributes initially had an even selection of score weightings. Each attribute had a total maximum score and the output was a simple fraction of the achieved score divided by the total maximum score. The questions had also been written in either a positive or negative sense in terms of their effect on safety culture and in accordance with best practice for Likert protocol (Krosnick & Presser, 2010). The calculation process of each of the attribute value is shown by example in *Figure 10*. The full Likert questionnaire list with their post calibrated weighting, orientation and code groups are described at Appendix A.

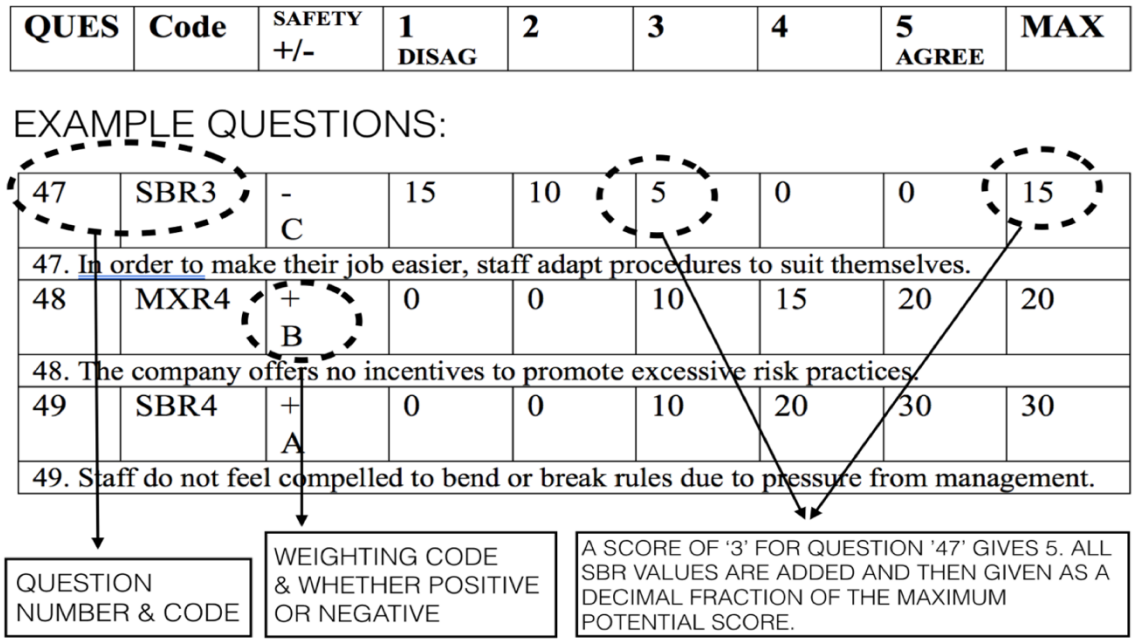

Figure 10 The scoring logic of d3SC using Likert questions 47-49 as examples.

Figure 10 is an example taken from the full scoring algorithm at Appendix A. Moving from left to right the question number (47) and question code (SBR3 – Staff Breaking Rules number 3). The next column shows the question grade; question 48 is a 'B' and is positively biased. *Figure 10* then shows the scoring boxes. Question 47 scores a '3' from the top box which gives a score of 5 out of a maximum of 15. The total scores of each attribute is added and represented as a decimal fraction.

4.2.3 Metrics of Culture & Causation

The next issue to be considered is how to effectively and efficiently import the Likert questionnaire data into d3SC. Before any testing of the d3SC model could begin a number of issues had to be considered. The first was to define what was being measured; the conceptual foundation of d3SC suggests that the often-conflicting demands of conceptual efficiency and conceptual accuracy needed to be considered. Efficiency could be improved by providing a score value to each attribute and merge these to produce a singular value of the whole organisation. This approach obviously aggregates or even hides the interaction between attributes. Conversely, an overly detailed analysis of each attribute compromises the patterns within the output data; the organisation's overall safety culture effectiveness relates to corporate liability and is therefore the key element which needs to be described. The most appropriate tactic was considered to be to apply scores to the individual attributes and thereby provide a *description* of areas of strength and weakness within an organisation. However, to provide an *explanation* of the causal dynamics, or how the attributes interrelated, a scoring mechanism was required to combine all the attributes into one visible output.

Consideration was given to applying Bayesian inference[77] to each output to represent relative confidence as the calculation ran through each attribute. The use of Bayesian logic has been applied to legal process, particularly where scientific evidence needs to be interpreted in a logical and probabilistic manner, (Fenton & Neil, 2012). Its use within other areas of complex human interaction and expert decision making[78] has been challenged, (Gelman, 2008). It was considered inappropriate for d3SC. There were two main reasons why the use of Bayesian logic was rejected for this model. The application of a Bayesian probability algorithm leads to issues of causal complexity; d3SC is intended to be read in conjunction with implicit causal assumptions, giving a visual representation of the relationship between safety culture values and values of corporate liability. A compound algorithm across all nine attributes, in numerous permutations would not satisfy that requirement given the computational intensity of Bayesian calculation. The

[77] Bayesian logic can be applied to statistics to provide a probability inference but more usefully in this context can be applied to make cohesive justification for confidence levels of an unknown outcome, (Fenton & Neil, 2012).
[78] The term here has a specific meaning where intuitive decision making of experts in complex situations can incorporate massive amounts of information in very little time or incorporate much broader implications than are included in formulaic or analytical decisions (see Klein, 1999).

second reason is that the Bayesian process begins with a priori knowledge of a set of assumptions. These are the same set of subjective assumptions relied upon by the legal system with which to describe the causal relationship between safety culture and liability for damage, death or injury. As a compromise, a simple probability matrix was developed to describe the relationship between each attribute in the model. The logic is intuitive and therefore can be used to articulate the influence which each attribute of safety culture has on the most sensitive immediate relationship and also the system as a whole. The output of d3SC is therefore not confined to either a functionalist or interpretative approach to explaining an organisation's safety culture but can provide elements of both perspectives.

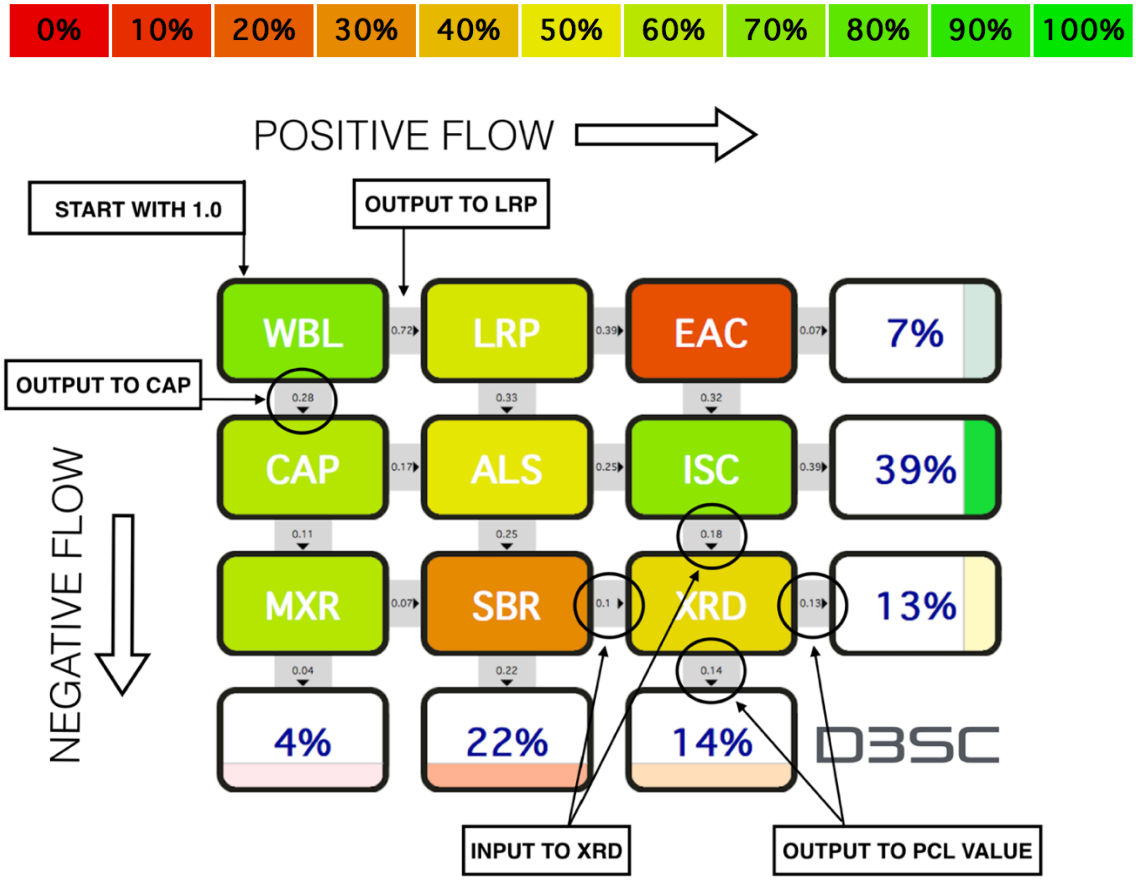

Figure 11 The logic flow of d3SC using basic probabilities.

4.2.4 The Logic of d3SC

The logic flow of d3SC is described by way of an illustrative example shown in *Figure 11*. The example shows a starting input with a probability of '1' i.e. certainty, which is then split into positive and negative fractions determined by data input. In this example,

the ratio of positive to negative is determined by the value applied to WBL. The scoring flow then follows the causal pathways discussed in Study One. If we consider the value of WBL, the commitment of senior management is paramount and presides over the whole organisational culture. However, the most direct and influential relationships are positive influences on the authentic application of the principles of ALARP (coded as LRP) and negative, if sub-cultures or common and accepted practices are not managed (coded as CAP). The fraction of positive score output would feed right-handed to LRP and a negative score would score downwards to feed to CAP. Each attribute receives inputs and the attribute score influences the ratio of their ongoing outputs; the probability cascades through the matrix. The cumulative output of the whole matrix feeds down and eventually into the Potential Corporate Liability (PCL). The PCL score shows as percentages of probability distributed between six levels of safety culture performance. In summary, the basic relationship between each attribute is therefore expressed as a simple decimal fraction and the total output of PCL as a percentage probability. The individual values of each are shown as a simple traffic light system with red as negative and green as positive.

4.2.5 Reading d3SC

d3SC was designed to give the reader an initial and rapid impression of the value of safety culture at group, departmental and organisational levels. It uses an intuitive 'traffic light' colour system described above in *Figure 11*. All the boxes have differing weightings represented position in the box. Patterns or features of individual safety cultures can then be identified and compared to other groups within an organisation or different organisations. In the simplest terms, the output of the model produces a colour coded faceplate which differentiates attributes of a strong or weak safety culture. The units show their individual scores as well as the collective scoring of the organisation's safety culture. The output from the model has also an inferred threshold between civil and criminal liability. To the right-hand side, the better safety cultures would face the civil litigation system, invariably covered by insurance. The poorer performing organisations that scored below the red line might face the uncertainties and more extreme penalties associated with the criminal justice system.

4.2.6 The Length & Breadth of d3SC

The output of d3SC can be read as a 'map' of an organisation's safety culture giving the ability to read horizontally and vertically to gain insight to the subject safety culture. The faceplate reads left to right with the left-hand side being more directly influential to aggregate performance and influence gradually reducing in the centre and right-hand column of attributes. The vertical tiers of the faceplate broadly represent the hierarchy of an organisation:

1. The top line represents the areas primarily influenced by senior management. i.e. the level of senior management commitment (WBL), guiding principles of organisational safety policy, (LRP) and finally senior management's ability to communicate (rather than broadcast) their commitment to safety to the workforce (EAC).
2. The second tier represents the primary spheres of influence of middle management such as internal compliance management (CAP), efficiency trade-offs to acceptable levels of safety management (ALS) and finally efforts to manage and improve safety culture attitudes of the workforce (ISC).

3. The third and lowest tier focuses on issues primarily associated with the influences and attitudes of frontline staff; this level effectively describes many of the organisational symptoms of safety culture. It indicates to what level that real, or perceived incentives to make excessive risky decisions to reduce cost or increase profitability, are seen as corporate policy (MXR). Whether rule breaking to achieve tasks (SBR) is observed or condoned and finally how or whether individual excessive risk taking is discouraged through training and managing the workforce (XRD).

As the algorithm links each attribute through a cascading probability of influence, it describes a functionalist perspective of attributes of safety culture to potential corporate criminal liability. It also presents a visualisation of the causal influence from senior management, though the compromises and trade-offs of middle management right through to the activity of frontline operatives. Finally, it provides an overall description or interpretation of safety culture throughout the organisation.

4.2.7 Angels & Demons

An organisation that wished to develop a potential defence of due diligence would aspire to the probability route depicted by the angel. In summary, the organisation would have authentic commitment from its senior management in all areas of safety and risk management. It would follow best practice and more to minimise reasonably foreseeable risks, obvious or otherwise, to as low as reasonably practicable. Such a company would exert sufficient corporate energies to inform and educate its workforce to ensure compatibility of operational staff with corporate safety policy. In contrast, a company whose senior management did not demonstrate authentic commitment to safety and allowed the emergence of sub-cultures with separate common and accepted practices of safety and risk management, does not score well, the causal description is described by a demon. Coupled with evidence that tacit encouragement of such corporate practices occurred, a fatal accident would undoubtedly attract a prosecution from the criminal justice system.

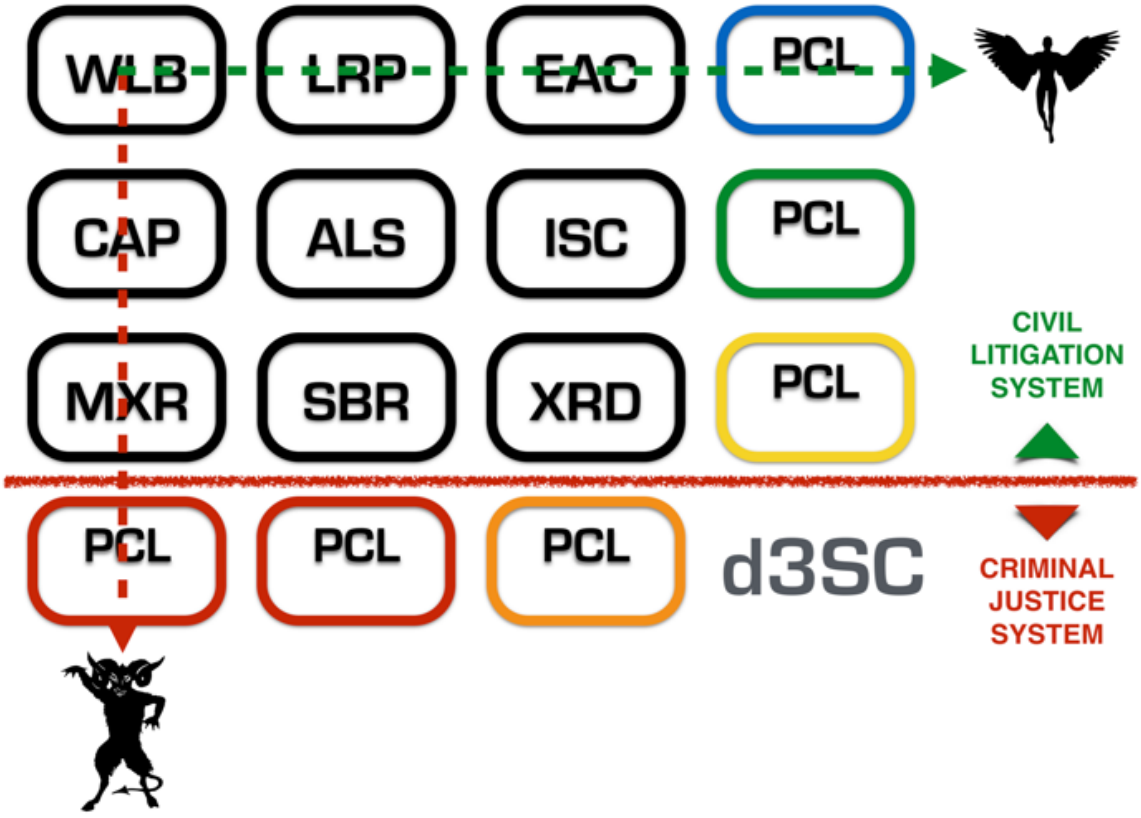

Figure 12 The metaphoric Angels & Demons of d3SC

4.2.8 Utilising d3SC

The illustrative extreme examples of 'Angels and Demons' described in *Figure 12* are clearly atypical of most organisations engaged in safety critical activity. The model is based on extremes of either high corporate liability principles compared with the worst examples of failed safety cultures. The immediate reality for most organisations is the appropriate allocation of scarce safety related resources. The output or faceplate of d3SC not only provides an intuitive display of where those resources might be best allocated but also provides a reminder to the more commercially minded why those resources are highly prioritised. The diagram at *Figure 13*, shows a comparison with the safety culture maturity scale developed by Parker *et al*.

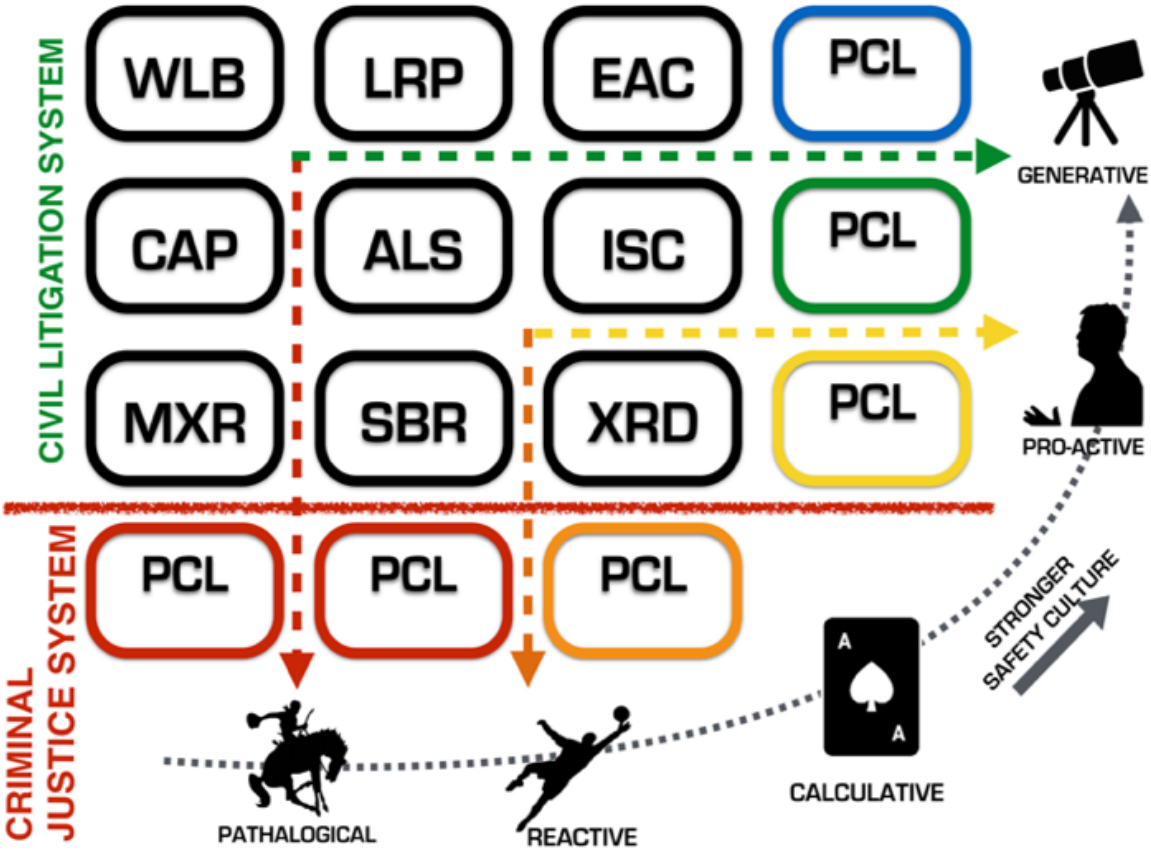

Figure 13 A comparison of d3SC with Parker et al's (2006) linear model of safety culture.

As *Figure 13* shows, a defence of due diligence (shown by the green line) is compatible with a generative safety culture whilst a pathological or reactive culture is exposed to criminal proceedings (red & amber lines) should they be unfortunate enough to be involved in a fatal accident. In many of the case studies, the key explanatory area of

failure is generally not at the extremes of egregious behaviour but revolves around those involving middle management and their efforts to balance competing influences and limited resources. Hollnagel (2004, 2014) refers to this managerial balancing as ETTOs, efficiency - thoroughness trade-offs. d3SC gives a visual description of potential causal routes of accidents and incidents which could implicate the corporate body. At the same time provides a description of which elements or attributes require the most immediate attention and resource.

Poorly resourced operations can often remove the ability for frontline staff to pro-actively manage risk; they are left to react to threats and errors. An organisation that continually sits in the reactive-calculative area of safety culture may achieve regulatory minima at an item by item safety case level and demonstrate immediate financial benefits, but in the longer term exposes the organisation to disproportionate levels of risk through its operational vulnerability.

4.3 Testing d3SC

4.3.1 Introduction

This section will describe how the prototype model of d3SC including the Likert questionnaire and hybrid scoring system was tested against real world data. The theoretical model was the product of a process of grounded theory but had to accurately represent the safety related 'values and attitudes' of the participants. The algorithm allowed the variation of question weighting, so the output could be appropriately adjusted. The pattern of the attributes had been developed from constant comparison with case studies and previous research which had attempted to measure safety culture, but how they interrelated in real world scenarios required further exploration.

A statistical validation was considered for the Likert questionnaire. However, as the questions had been purposefully selected and grouped by the researcher then subsequently graded by a legal professional, statistical validation such as principle component analysis and correlation assessment were considered inappropriate. The development process had deliberately pre-loaded anomalies into the scoring process as part of the logic of the algorithm. However, this left a requirement for an alternative and appropriate test process. Creswell & Clark (2011) note that while developing a rubric for scoring qualitative responses is a relatively common research practice, transforming quantitative data into a qualitative narrative is relatively rare. As this method was relatively untested, a three-phase pilot study was designed to validate the interpretation of qualitative and quantitative data. Bryman, (2006) recommends the adoption of differing perspectives in mixed method research design in order to improve data reliability and to enhance the researcher's objectivity.

4.3.2 A Three-Phase Pilot Study

The purpose of the pilot study was to establish how accurately the Likert data was being translated by d3SC and in turn how accurately the researcher could articulate the d3SC output into a brief written summary. The mixed methods approach was designed to test the reliability of d3SC through a three-phase pilot study with the following aims:

1. To assess how accurately d3SC could describe the safety culture of an organisation with which the researcher was familiar.
2. To measure the accuracy with which d3SC could articulate safety cultures unfamiliar to the researcher through reading the output of d3SC through the faceplate.
3. Assess how effectively d3SC could articulate safety cultures and attributes of corporate liability described from previously assessed case studies.

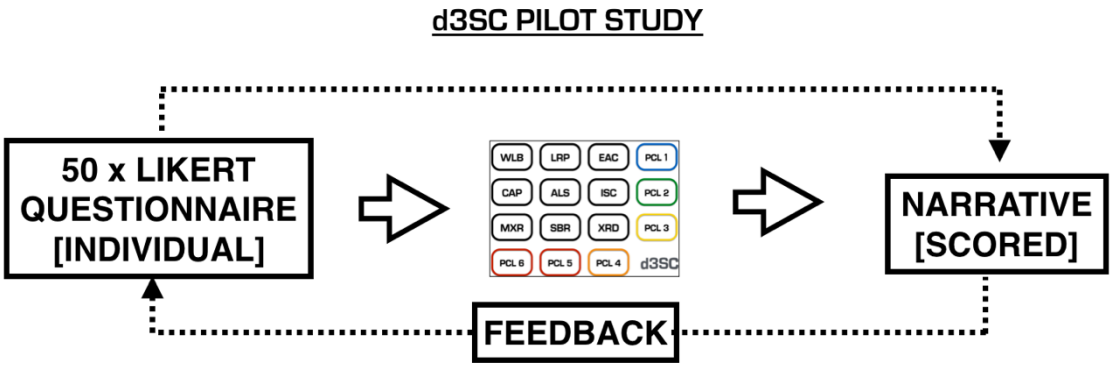

Figure 14 A description of the assessment cycle for the initial trial phases of d3SC.

4.3.3 Phase 1: Known Safety Culture

The first phase of calibration was informal and was conducted during July and August of 2015. Sampling was purposive; each participant had worked within the organisation for a minimum of ten years and was known by the researcher. Initially, fifteen participants were approached but due to differing work schedules only ten were able to provide data. All participants had demonstrated an interest and knowledge of safety process through their involvement in safety and human factors training. The employer's safety culture was known to the researcher and the participants and so served as an initial benchmark to develop the model against the purposive sampling of the organisation. As the process was informal and not subjected to ethical approval, no data was retained through this phase of

informal trialling. The scores were calculated manually and then discussed with the participants. A short, interpreted summary was given to each participant for scoring. The scoring was a simple 10-point scoring system; 10 being highly accurate to 1 being an inaccurate assessment of the candidates' description of the organisations' safety culture.

As well as scoring the accuracy of the researcher's interpretation of the d3SC result the informal nature of this phase prompted discussions on what story the participants were trying to convey in their answers. Following the first five iterations, and achieving a mean score of 6.2, the weighting of the algorithm (see *Appendix A*) was adjusted, i.e. low scoring values were reduced and the total score for grade 'C' questions were increased slightly. The initial results and subsequent discussions were showing a tendency for d3SC to merge and aggregate scores which gave insufficient differentiation between positive and negative attributes. The score weightings were adjusted to better represent low commitment by reducing points for the lowest two options and increasing points for higher commitment options. A repeat exercise following the assessment cycle described in *Figure 14*, which increased values over five further trials to an average accuracy of 7.2. Further adjustments, including a reduction of the two lowest scoring values to zero was made. The next five trial subjects produced a mean score of 8.2. Using the judgement data sample, further adjustments became counterproductive. d3SC was now describing one safety culture with reasonable accuracy. The scoring values of all questions constitute the algorithmic calculation of d3SC and a complete list of final question values is presented at *Appendix A*. Comparing the scoring with the participants comments provided a benchmark of sufficient accuracy. A nominal target of 7.5 and above was nominated as an acceptable benchmark for validation as it related to overall positive feedback concerning accuracy in the participants summaries.

4.3.4 d3SC.co.uk

The manual calculation of the scores presented two main problems for the research to proceed. The first was the amount of time taken to calculate and then discuss the d3SC results. The ability of the researcher to hold the subject's attention was stretched as each process took almost forty-five minutes. This was clearly impractical if the research was to capture multiple data sets from even small organisations. The second issue was accuracy as the repeated manual processing of results were susceptible to calculation

error. The algorithm was written into a code by a programming specialist[79] which could be accessed through the internet. The program immediately improved speed and accuracy. From receiving the answers to providing a spoken explanation was under two minutes and under ten minutes for a written assessment. The internet-based programme now allowed the testing of larger groups and made remote testing a practical option for future trials.

4.3.5 Phase 2: Unkown Safety Cultures

The next phase of trials involved subjects from employers not previously known to the researcher. As this phase of the trial was more formal and the data encrypted and retained, further ethical considerations were addressed in the trial design. Although no restrictions were placed on the research process by CURES, the process and the data were treated with an appropriate level of confidentiality throughout the trial. No references to the participant could be traced through the programme and any email exchanges were redacted then deleted. The researcher was left to produce a written narrative from only the faceplate output of d3SC.

4.3.6 Testing d3SC.co.uk

The researcher delivered a series of lectures at Cranfield University on the subject of aviation safety and law between September 2015 and December 2015. During these lectures, the d3SC process was explained to the group before inviting participation from attendees. Each group were given participation code which was now available through a dedicated website: d3SC.co.uk. Purposive sampling was determined suitable for the trial process as the subjects had showed an academic or professional interest in safety management determined by their attendance on the course. The subjects were allocated a session number and password to reply within a 24-hour window. Eleven replies were received. The output from the questionnaire appeared to the researcher in the format described in *Figure 14*. The diagrams show how the researcher interpreted the output or faceplate of d3SC to convert into a short narrative. The coloured ovals and lines show were the section of the d3SC result the narrative was derived from.

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[79] The computer coded version of d3SC was written under specific instructions from the researcher by Mr Alastair Steel, the sole proprietor of AS Webb Ltd: http://www.asweb.co.uk and is based entirely and accurately on the algorithm described in this thesis.

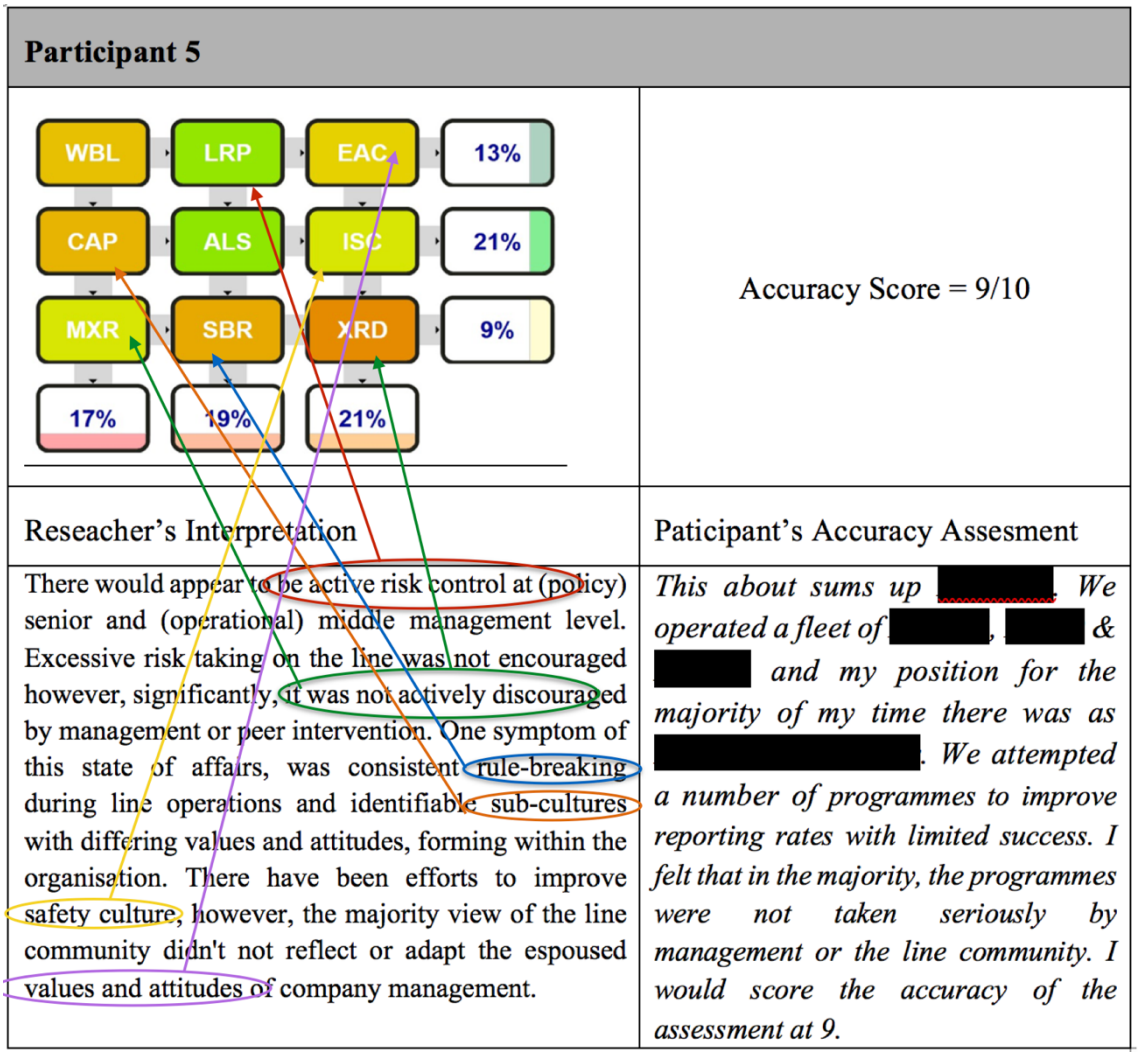


Figure 15 A worked example of the 'blind' validation process showing how the researcher interpreted the d3SC output.

Participants were offered an individual explanation of their results, by e-mailing the faceplate back to the researcher. To minimise any potential bias, participants were asked to use an email address which gave no reference to their employer or the subject organisation of their answers. The participants were then asked to score the accuracy of the written description using the same 1 to 10 methods as was used in phase 1. The total set of results from this phase is at Appendix C. The mean accuracy score for all eleven participants was 8.7. *Figure 15* shows a worked example of one of the phase 2 results, the written description from the researcher and the score and comments from the participant. Any references to the participant or the participant's employee has been redacted from their written comments. The subject's reports interpreted through the

researcher's written assessments identified several prevalent themes during this phase of trialling. The most common included low commitment to safety from senior management, middle-management balancing trade-offs and rule breaking. Notes were made where these phenomena were correctly identified by the researcher for future assessments.

4.3.7 Phase 3: Well Known Safety Failures

The third phase of validation involved d3SC interpreting the case studies referred to in Chapter 2, Part 2 in *Tables 2-2 and 2-3*. The reports all mention various attributes of safety culture so the objective of this phase of testing was to assess how d3SC identified and interpreted these attributes. If the d3SC output was simply binary and described either a strong or weak safety culture or aggregated the attributes, it would provide limited analytical value so using actual accident case studies was considered an appropriate test of interpreting more egregious organisational behaviour.

Spanair Flight 5022 accident at Madrid Barajas Airport: 2008 **154 Fatalities**		Low commitment from senior management seems to have affected the low ALS score. The company's operational standards are reflected here and this allows low SBR, or rule breaking. The low score for ISC suggests that little commitment was given to developing the company's safety culture. Similarly, insufficient resources were allocated to improving overall operational standards. This overall low priority given to safety was directly implicated in the accident.
Loss of Air France 447, F-GZCP, South Atlantic, 2009: **298 Fatalities.**		The ALS score suggest operating standards were generally upheld and gave no suggestion of management incentivising excessive risk practices. The top line attributes that are normally associated with senior management suggest whilst there were some effort to develop safety culture, it was compromised. There is no recognised improvement in safety culture by employees. The low CAP scoring indicates that sub-culture behaviour and SOP breaches are issues that senior management failed to address.

Figure 16 The d3SC interpretation of two case study examples.

4.3.8 Patterns of Organisational Failure

Organisational failure is not a random event. The fact that accident causation models referred to in the literature review such as High Reliability Theory or Normal Accident Theory exist, suggest systems failure follows some form of patterned behaviour (Leveson

et al. 2009; Shrivastava et al. 2009a; Dekker 2005, 2011a). This phase of the pilot study was conducted to identify how such patterns in organisational behaviour were interpreted by d3SC. Patterns of organisational failure have been suggested by a number of researchers and include *inter alia* efficiency thoroughness trade-offs, (Hollnagel 2004), organisational learning (Senge, 2006), practical drift (Snook, 1996) and the normalisation of deviance (Vaughan, 1997).

4.3.9 Perspectives on an Accident

The twenty-six accident and investigation reports listed in *Tables 3-1* and *3-2* were put through the d3SC process. The accident reports were reviewed and the d3SC questionnaire was answered from the perspective of the report. The nature of this process is subjective as the researcher had to synthesise the Likert answers from the perspective an employee of the operator, based on the report's description. This was obviously influenced by hindsight and the researcher's knowledge of the accident reports. The full results of the process are given in tabular form at *Appendix D*. *Figure 16* shows two contrasting reports are shown below with their descriptive assessments.

4.3.9.1 Adding Standard Deviation

Using d3SC to describe the case studies is a subjective interpretation of a retrospective view of an accident. The process drove the question of how confidence in the interpretation of each attribute could be increased. The ability to display confidence levels of each scored attribute was addressed by the addition of an indicator of standard deviation within each attribute block.

The lack of this feature had not been an issue in the calibration and testing of d3SC thus far as each case represented a single point of view. As the tool was now going to assess the values and attitudes of potentially large sample groups, it provided an extra level of awareness on the strength and focus of feeling within each. The lower vertical line shows the score by its position. The further right, the more positive the attribute score. The shadowed section gives a pictorial indication of the standard deviation. The narrower the deviation shadow, the higher the level of consensus over that attribute.

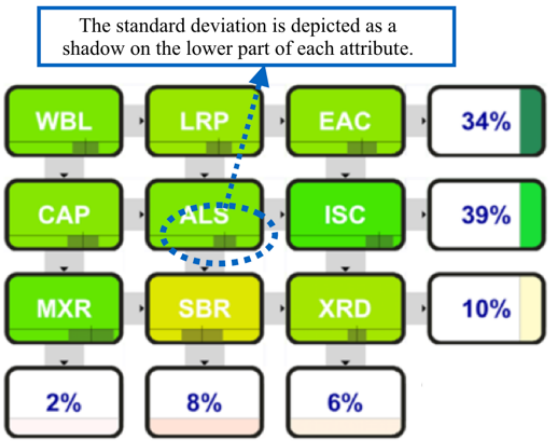


Figure 17 The addition of standard deviation.

4.4 Discussion

The result of the three phases of trialling increased confidence in the interpretation and explanation of d3SC output both as an interpretative and functional mechanism. As an example, the faceplates of the two accidents in *Figure 16* indicate very different causal attributes reflected in the associated description. The report of the Spanair accident focussed primarily on middle-management issues which lead to procedural and human error. The causal attributes of Air France 447 are far more obscure. The report suggests that senior management influence was a factor but does not categorically describe how that issue became manifest in the crew's actions. Both accidents resulted in criminal charges being brought against those deemed responsible. Spanish criminal law only recognises corporate liability as accessories to individual criminal acts, (see *Table 2-3*).

In contrast, French law recognises an organisation as a legally responsible body and at the time of writing proceedings were ongoing. As discussed earlier in the chapter, this version of d3SC is based on the CMCHA, however many of the principles of corporate criminal liability are supranational. In terms of potential liability, the value of d3SC is possibly more descriptive than predictive but re-enforcing the link between safety culture and liability could enhance corporate risk awareness of safety management. In its PCL scoring d3SC suggests both organisations could face prosecution as there is a causal link between poorly performing organisational attributes.

At this stage in development, utilising the model as a predictive tool would be speculative as criminal prosecution of corporations vary immensely between different jurisdictions. To provide any predictive capability there would certainly need to be other sources of evidence to supplement the d3SC data. However, d3SC did provide an efficient risk management tool with which an organisation can recognise areas of potential concern. It terms of risk management d3SC could direct the allocation of proportionate level of resource to resolve any issues in poorly performing attributes of safety culture before they potentially become legally recognised causal elements to an accident.

4.5 Conclusion

This study followed the progression of d3SC from a theoretical model through development and testing towards a functioning risk management tool. The theoretical background of the model emphasised the need to consider the juxtaposition of functional efficiency and ethnographic accuracy. The model used data from a recognised safety culture assessment source, the Likert questionnaire and translated the data through the nine attributes of d3SC into a potential corporate liability score (PCL). The PCL output reflects the law's changing relationship with corporate conduct in safety critical activities. This relationship has proved to be complex and has not subscribed to traditional models of legal liability. As such the development of a tool to assess the overlap of two complex concepts as culture and causation require innovative research and perspectives. The study looked at three groups; a known safety culture, individual perspectives of different safety cultures and finally a series of failed safety cultures. The combination of approaches was intended to develop a benchmark of organisational behaviour patterns with which further studies could translate into predictive patterns of potential corporate liability. The next

stage in the development of d3SC was to test its effectiveness in interpreting and assessing multiple perspectives of the same organisation.

5 STUDY THREE – A d3SC Assessment of Airamp

5.1 Introduction

When commercial aviation organisations consider how to improve their own safety performance they are left with the persistent dilemma of what to aim for. The inherent problem with assessing safety culture against safety performance is effectively described by Amalberti (2001) as the paradox of ultra-safe systems. Few practical mechanisms are in place to meaningfully determine micrometrics of safety performance in commercial aviation, (Lofquist, 2010). d3SC does not directly attempt to measure or represent an organisation's safety performance but attempts to quantify its potential corporate liability as a surrogate metric of safety performance. By directly engaging organisational risk management with potential corporate liability, safety standards are encouraged to comply with socially acceptable risk practice rather than embracing complacency based on ultra-low probabilities of accidents. Potential corporate liability is arguably a more effective metric as it compels the risk management decision makers to actively consider 'what if?' rather than consoling themselves with counter-factual arguments that justify complacency.

5.1.1 The Aim of the Study

This aim of this study is to assess the d3SC's capability to express real-world data by representing an organisation's safety 'values and attitudes' from differing perspectives within a single organisation. The previous real-world data was assessed against individual opinions of organisation's safety culture. To triangulate the output data of the trial, this study will explore the validity of d3SC data through semi-structured interview. By comparing the inferences made through the d3SC processes developed in Study Two with the more naturalistic data sources of feedback scoring and interviews, the reliability of the d3SC tool can be assessed.

5.1.2 Sourcing Real World Data

The initial testing of d3SC in the three-phase pilot study gave sufficient confidence in the process that the model could now be applied to a real-world environment. However, as discussed in the previous chapter, the study's association with corporate liability had restricted potential data sources. A research proposal was made to an organisation with

which the researcher had a previous professional association and had established a relationship of trust. The organisation had ambitions to improve its safety culture and the d3SC process was suggested as a possible method to assist with that programme. The research proposal contained measures to ensure as far as reasonably practicable, organisational and individual anonymity. Research access was granted following a presentation to the organisation's board and an agreement was reached that protected organisational reputation but allowed access to obtain authentic and verifiable data. As part of this agreement, all trial data was stored on encrypted hard drives within a private and secure location. For the purposes of the trial and all subsequent data sharing the organisation was allocated a pseudo-name, Airamp.

5.1.3 Introducing Airamp

Airamp is European aviation organisation with between five hundred and one thousand employees spread between several geographically separate departments. The size and the geographic dispersion of the various departments meant that at least part of the study could not be carried out face-to-face with the research subjects, so the research design had to consider techniques for remote data capture. The first two studies, Airamp 1 and 2 focused on the attitudes of employees at management level. The third trial, Airamp 3 then assessed attitudes at middle-management and operational level at five of Airamp's departments. In the past, feedback had been given by a regulatory body on the state of Airamp's safety culture and Airamp had committed to a programme of continual safety culture improvement. This report aims to assess d3SC's potential in contributing to that process by highlighting potential areas of organisational strengths and weaknesses and to incentivise positive improvements from all areas of Airamp.

5.2 Methodology

5.2.1 Trial Overview

The sensitivity of the subject matter restricted the trial design and methodology to a certain extent. The requisite trust required to conduct an organisational assessment of potential liability to corporate crime cannot be created on demand. For this reason, the Airamp assessment was conducted in three phases. Each phase building on the accrued knowledge and mutual trust between the researcher and Airamp. The first two stages of

this trial, Airamp 1 & 2, used the same process to collect data as had been used in Study Two and were conducted as part of ongoing management training symposiums. These first stages of the Airamp trial had two main objectives. Firstly, to establish that d3SC could usefully interpret multiple opinions of an organisational culture; the output faceplates of d3SC were designed to provide a visual representation of Airamp's safety culture by starting to provide a sequence of imagery to show emergent patterns. The second objective was to consolidate trust between the researcher and Airamp management in order to allow further trials that would assess safety culture across a broader sample of the organisation during Airamp 3. The objective of Airamp 3 was to cross refer differing departments within one organisation and determine whether d3SC could be utilised to identify areas were improvements to safety culture could be targeted. Ultimately, the process was designed to build the foundations of a defence of due diligence by demonstrating progressive and systematic efforts to improve safety performance, (Gobert & Punch, 2003).

5.2.2 Three Airamp Surveys

The three surveys conducted with Airamp were held between December 2015 and April 2017. All data was promptly redacted and separated from its initial source following collection and storage:

5.2.2.1 Airamp One

This phase of the trial was conducted in December 2015, at Airamp's offices. It was held as part of a periodic safety seminar at the company headquarters and involved senior and middle management. The results and assessment were displayed within 30 minutes of the group completing their questionnaire. The group were then asked to provide a score out of 10 of the assessment's accuracy via a discrete scoring card.

5.2.2.2 Airamp Two

The second stage in the trial ran in September 2016 also involved senior and middle management but was conducted offsite from the company headquarters. The d3SC questionnaire was also conducted as part of a safety seminar and the same discrete scoring process from Airamp 1 was followed.

5.2.2.3 Airamp Three

The final stage of the trial was conducted remotely via email, internet connection and telephone. Initial data was obtained from the end of November 2016 to the second week of December 2016. Subsequent interviews and a group discussion were undertaken in April 2017. The five geographically separated departments are referred to as Airamp 3A through to Airamp 3E. Five individual access codes to d3SC.co.uk were sent to Airamp's head office for random distribution to each department. Each department was given a brief description of the process via a common power point presentation introduced by the local departmental manager. To promote objectivity the researcher had no knowledge of which departments within Airamp that were being assessed.

5.2.3 An Overview of the Airamp 3 Trial

As illustrated in *Figure 18* employees at each department were invited to answer the questionnaire at their convenience during a three-week window. The biographic questions allowed the outputs to be split between managerial and non-managerial employees. The output from each department was then assessed by the researcher. The output faceplates were read and interpreted by the researcher, and a brief written assessment was recorded. These results were then presented back to Airamp for scoring and feedback. This was obtained by semi-structured interviews with senior managers, the individual department managers and group discussion with both groups. Finally, professional legal opinion was obtained as to the legal credibility and potential utility of the d3SC process.

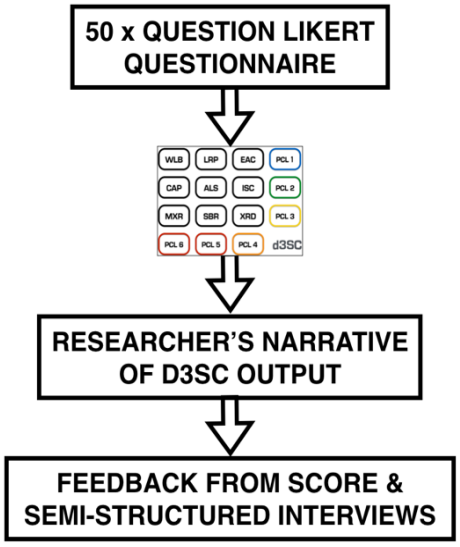


Figure 18 The design of the Airamp 3 assessment.

5.2.4 Triangulating d3SC Data

Following initial submission of the findings of the d3SC report, Airamp's management authorised a triangulation process of the safety culture assessment. The three phases were undertaken to assess the accuracy and context of the d3SC output. Following discussion with Airamp's senior management team an agreed interview format and content was established. To maintain confidence in the process and assurance that ongoing safety culture assessments could be reliably undertaken, it was decided by Airamp's senior management that the individual departmental results of the survey would not be fed back

directly to each individual department manager. This is not an ideal approach from a validation perspective, however a suitable compromise was agreed by directing each department manager to give an accuracy assessment of the overall analysis from Airamp 3. Accuracy of individual department scores were then obtained by interviewing three senior managers who possessed a long standing and regular working knowledge of each department.

5.2.5 Triangulation Through Semi-Structured Interviews

The use of semi-structured interviews allows research participants to influence the contextual relevance of the data rather than be restricted by the implied definition of structured questions (Ritchie *et al*, 2013). To mitigate some of the inherent weaknesses in Likert questionnaires, highlighted by *inter alia* Guldenmund (2007) the validity of the data from the main test of d3SC was assessed through triangulation from a series of telephone semi-structured interviews. Using a telephone to conduct interviews does deprive the researcher any ability of assessing body language and expression, however it can allow an element of anonymity and allowed an open discussion away from the formality of a face to face interview, (Irvine, Drew & Sainsbury, 2013). Explaining activities within context consumes valuable research resource, not least time and can tend towards the descriptive. However, finding a balance is key. Having conducted an initial open-line telephone conference, the structure of the interview was described. The private semi-structured interviews were restricted to two questions: a score and the justification for that score. This was designed to give maximum breadth to the subjects without corralling them into the researcher's predisposition to areas of significance. The researcher took notes from the interview in real-time. At the end of each section a summary of the participants answers was read by to them to check understanding.

5.2.6 Content Analysis

The flexibility afforded by content analysis was considered an appropriate method as the Airamp's management had restricted the direct interviewing of each department head directly about their department's results. Cross referring of the interviews of senior managers, middle managers and the d3SC results allowed a multi-perspective assessment of the organisation. The full interview answers are replicated at Appendices E, F and G. A process of content analysis was undertaken in order to contextualise emergent themes

from the interviews. Content analysis was considered an appropriate method to make an effective comparison between the researcher's summaries of the d3SC output data and the dialogue of the interviews. The process involved searching the data for broader patterns of meaning then reviewing these themes within the context of the data (Braun & Clarke, 2006). The process allows the exploration of emergent themes within the dialogue but without the theory building objective of grounded theory. The objective of this method of data triangulation was to allow comparison and contextual understanding between two sources; the interviews and the d3SC process.

5.2.6.1 A: Individual Semi-Structured Interviews with Three Senior Managers:

Three short, semi-structured interviews were by conducted over the telephone with senior managers from Airamp, entitled managers A1, A2 and A3. Each manager was given a copy of the d3SC report based on the December 2016 trial. The managers were given one month to read and consider the report contents. The report contained images of the d3SC faceplate and the basic function was explained. Each manager was asked to score the accuracy of the assessment out of 10 then give a justification for the score. The predominant themes of these interviews were developed through content analysis and appear below each department's d3SC report and the output from content analysis is described later in the chapter. A full description of each interview is provided at *Appendix E*.

5.2.6.2 B: Individual Semi-Structured Interviews with Department Managers:

Each of the five departmental managers was interviewed over the telephone after calling the researcher within a prescribed 48-hour slot. The identity of each manager was unknown to the interviewer and are referred to as B1 to B5. Notes were taken during the interview and clarification was sought from the interviewee to ensure the notes were an accurate reflection of the interviewee's opinion. A summary and output from the content analysis of these discussions appears later in this chapter and a full description of each interview is provided at *Appendix F*.

5.2.6.3 C: Group Telephone Discussion with Senior and Departmental Managers:

A telephone conference with the researcher and all the Airamp participants was arranged. The discussion was aimed at identifying what drivers existed within the organisation that

potentially influenced people's opinion about the organisation's safety culture. The comments in this discussion are attributed to the order in which each manager made their initial contribution to the discussion. Each manager is then referred to as C1 *et seq*. A summary and output from a content analysis of the discussion appears later in this chapter and a full description of the discussion is provided at *Appendix G*.

5.3 Airamp Results

Data acquired from the questionnaires are described below for each of the Airamp trials in the standard d3SC faceplate format described in the methodology chapter. The data is presented in two formats. The data from Airamp 1 and 2 is presented in three stages; the d3SC faceplate, the researchers written summary and an accuracy score obtained from the contributing group shortly after presenting them with the written assessment. For Airamp 3, the d3SC data is supplemented by the addition of selected highlights of the senior management comments derived through a content analysis of the three individual interviews. Below each set of pictorial d3SC results is a written analysis of the results. The trials engaged with three strata of working groups within Airamp:

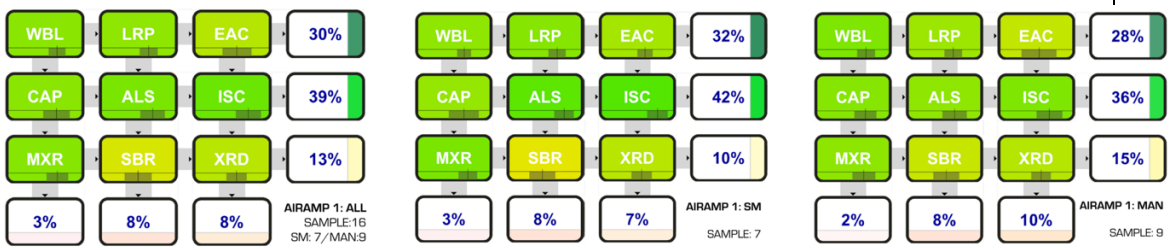
- Senior Management: **SM**
- Middle-Management: **MAN**
- Non-Management: **NON-MAN**

The left-hand box in each set of results shows the collective output of each section of the trial, for example, 'Airamp 1 ALL'. The other two boxes respectively show the different group's results, for example, Senior Management, SM followed by Middle-Management, MAN. For example, the first set of results Airamp 1 Results: ALL/SM/MAN, shows the overall (ALL) d3SC output, followed by Senior Management's output (SM), followed by Middle-Management output (MAN). The presentation allows comparisons to be made between different groups within the same survey.

The comments made in the written analysis, immediately below the faceplate are an interpretation by the researcher of the associated d3SC output and not with any prior knowledge of the sample group. The researcher had developed interpretative experience from assessing and memoing patterns from the examples listed in Appendices C and D. The accuracy scores are then displayed from either the group in Airamp 1 and 2 or individual senior managers in Airamp 3. In the Airamp 3 data displays, highlights from each of the individual senior manager's interviews, A1, A2 and A3 are shown for a convenient comparison with the researcher's written analysis.

5.3.1 Airamp 1 Survey Results

AIRAMP 1 - d3SC RESULTS: ALL/SM/MAN



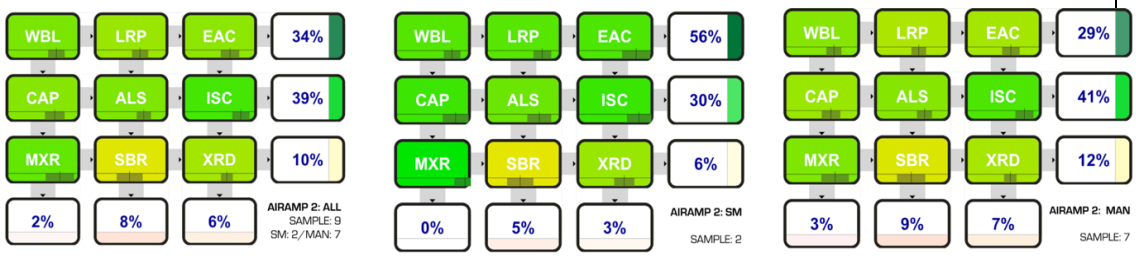
RESEARCHER'S ANALYSIS:

The results from this survey describe an organisation with a strong safety culture from the perspective of senior and middle management. The strongest and most consistent aspect of the results show continual improvements in efforts to improve safety culture across the organisation. This stems from a strong senior management commitment to safety as a business principle. Both senior and middle managers agree that safety and risk are appropriately addressed within the company, although middle managers are slightly less optimistic than their senior colleagues, that employee attitudes about how safety is managed are in-line with the views of senior management. The breaking of rules or Standard Operating Procedures (SOPs) is a significant concern, particularly by senior management and less of a significant concern from the perspective of Airamp's middle-management.

ACCURACY ASSESSMENT SCORE FROM GROUP: 8.4

5.3.2 Airamp 2 Survey Results

AIRAMP 2 - d3SC RESULTS: ALL/SM/MAN



RESEARCHER'S ANALYSIS:

The results of Airamp 2 show strong consistencies with those of Airamp 1. Overall the opinion of this group of senior and middle-managers is that the organisation has a strong and resilient safety culture. The strongest attributes identified by both groups are that excessive risk practices are positively discouraged by senior management and that the organisation is continually improving its safety culture. Again, senior management seem to have the strongest concern that rules and SOPs are broken by operational staff. Middle management are slightly more sceptical that risks are reduced to as low as is reasonably practicable and suggest there is some safety behaviour driven by sub-cultures within the organisation.

ACCURACY ASSESSMENT SCORE FROM GROUP: 8.7

5.3.3 Airamp 3 Survey Results

AIRAMP 3 – OVERALL d3SC RESULTS: ALL/MAN/NON-MAN

Researcher's Analysis:

These results suggest that in the opinion of managerial and non-managerial staff in departments A to E, there are areas for improvement in Airamp's safety culture. There seems to be consensus that safety culture is improving and that excessive risk practices are not encouraged or incentivised by senior management. However, across the board, insufficient discouragement from management to actively discourage corner cutting and inappropriate risk taking is an issue. Between the two groups there is disagreement on rule-breaking and SOP breach. It is not such a problem from the perspective of the non-management community, but it is a consistent concern from a management view-point. There is a reasonably consistent opinion, across the five departments that authentic commitment to safety from senior management could improve. There is also work to be done on making sure employee attitudes to safety and risk management at the operational frontline are more aligned with senior management's attitudes and policies.

A1 Accuracy Score: 6

- V*ery accurate in elements. Safety Culture is continually improving.*
- *Excessive Risk practices are not incentivised by management.*
- *I agree with the fact that more work needs to be done with employee attitudes to align with senior manager's attitudes to safety.*

A2 Accuracy Score: 7

- *Given the company there some staff changes at least within one of the location and that may have been factor.*
- *This creates bottlenecks where senior management may think things are lovely… but it doesn't always filter down or up the organisation.*
- *We* [senior management] *do however, have a more flowery description and view of safety and risk than the average guy on line.*

A3 Accuracy Score: 7

- *There is a definite bottleneck between them and us.*
- *The operational frontline and senior management trying to get the communication lined up particularly with the topography of the organisation and the community cultures are different.*
- *There is a completely different view of life between those in the north and south and west. They're all different.*

5.3.4 Airamp 3A Survey Results

AIRAMP 3A d3SC RESULTS: ALL/MAN/NON-MAN

Researcher's Analysis:

Although mainly a managerial attitude, d3SC suggests efforts to improve safety culture are making some progress, however, across the department the attitudes of the workforce and to some extent, management attitudes are not aligned with company practice and policy. Inherent attitudes between employees and senior management practice and policy cannot be fast-tracked into improvement in the name of safety, if there are established cultural barriers to authentic communication and trust. A lack of trust can impede progress to improvement even when consensus exists over areas of common interest such as improving safety culture. This issue of workforce trust is expressed as between the operational staff and senior management, rather than local management; addressing this relationship should be the focal point for development. Ironically, and in some contrast to other departments, Department A does not seem to have an issue with compliance at operational level. This despite the suggestion that cost cutting and excessive risk practice needs more emphatic discouragement from senior management. The overall picture would suggest the whole department is resistant to external and senior management intervention.

A1 Accuracy Score: 6

- *Safety Culture is improving we know that but we cannot fast track safety. That's where things go wrong. You can't just drag people into this process. They kick back.*
- *There is a perceived lack of trust between the unit and senior management.*
- *Local management attitudes differ from attitudes at senior and corporate level.*

A2 Accuracy Score: 7

- *Looking at personal relationships, now that could have potentially skewed the image of the safety culture senior management is trying to promote.*
- *That* [perceived cost-cutting] *even comes from some of the manager's meetings and looking at the bottlenecks of communication the information can be misinterpreted.*

A3 Accuracy Score: 8

- *The strength of the local manager is probably the biggest bottleneck.*
- *Depending on the leadership style and impact of that manager that has a huge impact on those at the sharp end.*
- *If the message is conveyed negatively then that the way it's received.*

5.3.5 Airamp 3B Survey Results

AIRAMP DEPARTMENT 3B d3SC RESULTS: ALL/MAN/NON-MAN

Researcher's Analysis:

Overall, Department B's safety culture is strong. There is a reasonably consistent belief that senior management's commitment to safety management is authentic. Both managers and non-managers see an improving safety culture within their organisation. Both groups also recognise that rule and SOP breaking is prevalent, although managerial attitudes seem to suggest that this is an operational rather than an organisational issue. Management show conviction that excessive risk practices are not encouraged in the interest of profit or efficiency. That feeling is not shared by their non-managerial colleagues. Non-managerial opinion suggests some inferred company support for rule breaking and do not see evidence that it is positively discouraged.

A1 Accuracy Score: 8

- *The report is very accurate in most content. We work hard to encourage it but yep, the safety culture is strong.*
- *There is an authentic senior management commitment to safety issues.*
- *Improving safety culture recognised by the operations guys, by the workforce.*

A2 Accuracy Score: 8

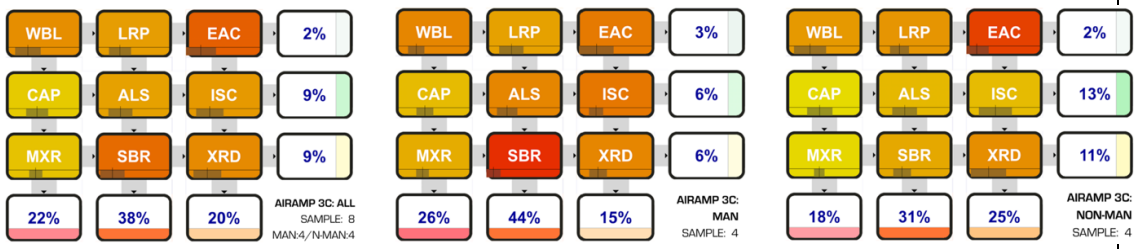
- *I think it's there. I would be of the view that the safety culture is improving.*
- *I think that airport staff believe there is commitment from the company but looking at how the operation is delivered there are areas of operation and SOPS where there are work arounds and we accept that from my discipline.*

A3 Accuracy Score: 7

- *In terms of my knowledge of this department they are very regimented.*
- *Listening to how they speak is very safety focussed. The disconnect is between senior management and the sharp end.*

5.3.6 Airamp 3C Survey Results

AIRAMP DEPARTMENT 3C d3SC RESULTS: ALL/MAN/NON-MAN



Researcher's Analysis:

Department C has significant vulnerabilities in its safety culture. These vulnerabilities extend across both management and workforce levels. Managerial attitudes are more critical of the generic state of safety management than those of the general workforce. That criticism is extended to the operational management of safety and risk, an area the respondents themselves, presumably, control. The most obvious and causal issue is the relationship between local management levels and senior management; there appears to be little belief that senior management has any authentic conviction to improving safety performance. In parallel to this attribute, the operational workforce describes a situation where there is no alignment of senior management practice and policy commitment and their own attitudes about safety and risk management. Department C's management do not see any improvement in the state of their safety culture and feel very strongly that rule breaking and SOP infringement is the norm. This managerial opinion is not as shared at operational level. The attitudes at operational level also differ over the encouragement of excessive risk taking by senior management; the operational workforce doesn't focus on this but their middle-management colleagues do. The survey would suggest management attitudes towards safety management within Department C warrant further investigation.

A1 Accuracy Score: 5

- *Its saying that there are vulnerabilities in safety culture across both workforce and management levels that are not apparent to me.*
- *I do however recognise there are relationship issues between management and operational staff.*
- *They don't get it or we are just not getting the message across.*

A2 Accuracy Score: 3

- *I don't see in this, not in terms of processes compared to the system that we have for intelligence gathering.*
- *If it is as bad as this then we should be seeing some evidence of systems break down, somewhere.*
- *I do accept there are areas of break-down in communications between senior management and staff.*

A3 Accuracy Score: 7

- *Okay, this department are a really, really, strong bunch of characters. Almost to the extent that the tail wags the dog. Very opinionated.*
- *There is a really strong 'them and us' feel about it. You can feel it.*

5.3.7 Airamp 3D Survey Results

AIRAMP DEPARTMENT 3D d3SC RESULTS: ALL/MAN/NON-MAN

Researcher's Analysis:

Department D would appear to have an excellent safety culture, particularly as this is advocated by its own workforce rather than any managerial level. The workforce recognises ongoing improvements to their safety culture and see an authentic and strong commitment from their senior management. Employee attitudes are compatible with those of the wider company, although further discouragement of excessive risk practices could be an area for the further improvement of an already strong and improving safety culture.

A1 Accuracy Score: 9

- *There is an excellent safety culture. This description is authentic almost in total.*
- *That's what makes this real it's not management saying this stuff but the guys.*
- *Yeah this is a better description of, well, across the board safety culture here.*

A2 Accuracy Score: 8

- *If you think where we have come from… where we were 7-8 years ago in terms of culture. The vast majority of them… that's what we get. I'm not saying across every airport we get it right.*
- *The environment would suggest that's a better reflector of the culture.*

A3 Accuracy Score: 9

- *The basis of the high score is the strength of the middle manager and the alignment of his thoughts with senior management.*
- *You walk into the department and you get that feel. Yep. Really accurate assessment.*

5.3.8 Airamp 3E Survey Results

AIRAMP DEPARTMENT 3E d3SC RESULTS: ALL/MAN/NON-MAN

Researcher's Analysis:

As there were only two responses from this department it is not appropriate to draw too many conclusions about the broader state of E's safety culture. The low response could be because E is a very small department or there is little to no meaningful engagement with this or other safety assessment measures. In either case, the picture is reasonably apparent at first glance. The manager respondent believes despite a relatively weak level of commitment from his central office and senior management, safety and risk practices are of a high level. There is a strong and improving safety culture with only minor transgressions of rules and SOPs. The non-management respondent sees a very different department. The most significant issue would appear to be the lack of authentic commitment by senior management to improve organisational safety. There is also tacit support of cost cutting and rule bending to improve efficiencies. There is little to no alignment between senior management policy and that of the workforce.

A1 Accuracy Score: 7

- *Safety and risk practices are of a high level.*
- *Guys on the line, they see a very different department. They see sometimes what they want to and sometimes, in some [departments]what they told to see.*

A2 Accuracy Score: 6

- *I think its reasonably accurate in that we have…I don't see that we have a low commitment to safety from senior management.*
- *We may be suffering from a lack of or poor communication and bottlenecking again.*
- *We are trying to increase efficiencies but not encourage rule bending. No, that's not the idea.*

A3 Accuracy Score: 6

- *Distant and very small department and tight community.*
- *The feeling that how dare senior management interfere with our operation. My thoughts are very similar to Department A.*

5.3.9 An Overview of the Airamp Survey

Figure 19, below, gives a pictorial overview of the output of the Airamp survey. The overall picture allows an improved perspective on the results of the relationship between Airamp's safety culture and perspectives on potential corporate liability. The initial two surveys Airamp1 and 2 show a strong and resilient culture with little to no indication of sub-cultures at any level. Airamp 3 provides a deeper insight into potential areas of vulnerability to liability. The significant features that emerged from the survey were the resistance to senior management influence in Department A and significant rule and SOP deviation in Department C. Across the survey managerial focus is focussed on rule and SOP breaking in contrast to the operational staff's focus on incompatibility with senior management policy.

Fang & Wu (2013), suggested that attempting to model a singular safety culture was futile as the dynamics of any singular project let alone organisation determined the driving force of safety behaviours. The traditional delineation of working groups, in the case of their study of a construction company, of owner, contractor and sub-contractor were superseded by the evolving dynamics of proximate sub-culture influences. The overall picture of Airamp's safety culture determined simply by the colour coding of d3SC draws attention to three possible areas of subculture development: Department C, Department A and of senior and middle management attitudes and values depicted in Airamp 1 and 2.

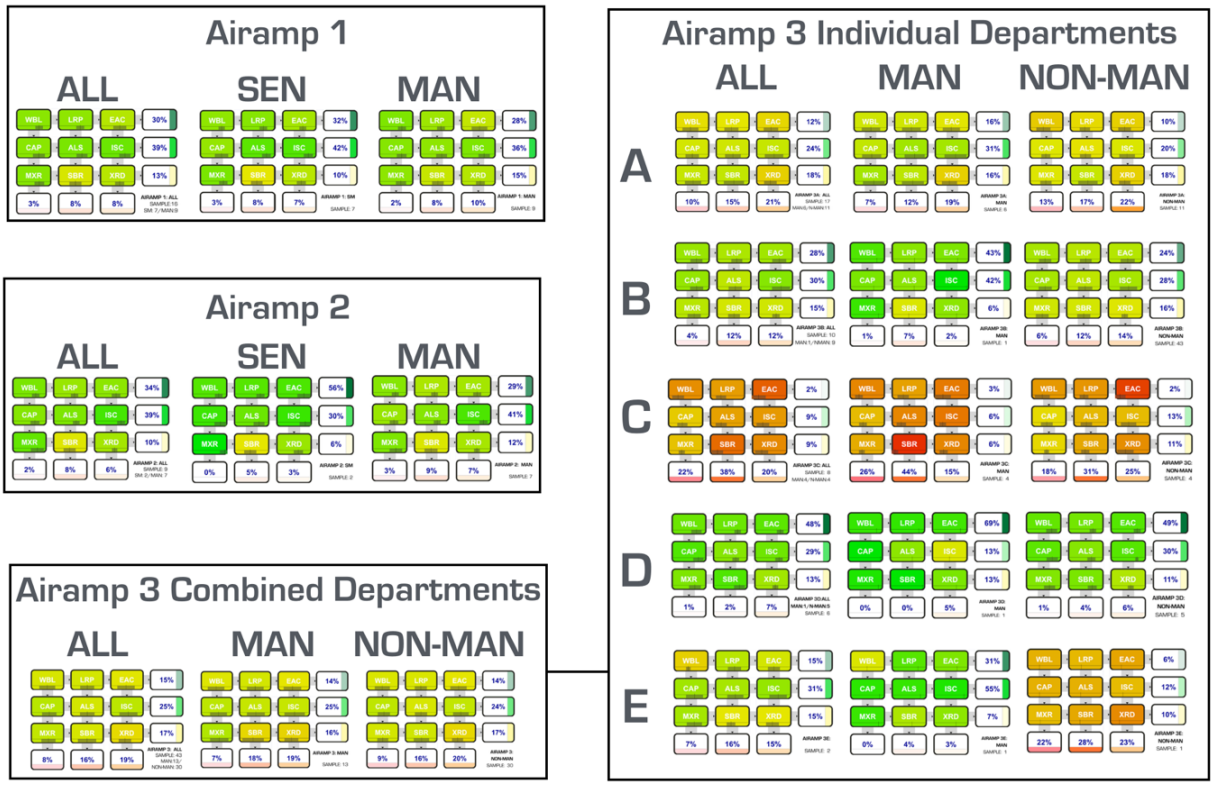


Figure 19 An overview of the d3SC assessment of Airamp.

5.4 Triangulating the d3SC Results

Derived from the information in the above d3SC outputs, a content analysis of the researcher's written assessments identified a number of themes throughout the survey which are numbered below. Each of these points will be analysed in relation to the overall patterns emerging from the survey and relative to established theory:

1. There is strong consensus in the opinion of senior management in Airamp 1 and 2 as to the positive and strong nature and quality of Airamp's safety culture.

2. There was generally a recognition across the d3SC survey of some success in efforts by the management team to improve safety culture.

3. The opinion of senior management about the nature of Airamp's safety culture described in Airamp 1 and 2 is shared by at least two of the five contributing departments[80].

4. Senior management attitudes to the nature of Airamp's safety culture described in Airamp 1 and 2 contrasts with at least two of the five surveyed departments[81].

5. A consistent senior managerial focus was on operational rule-breaking or breach of SOPs rather than issues at a higher organisational level.

6. A consistent operational focus was on a misalignment between senior management and operational safety perspectives.

7. The contrast between the weak output from Department C and conversely strong output from Department D in the survey is worthy of further investigation.

8. Departments A and C output suggested some vulnerabilities in these department's safety cultures.

Points 1 and 2 suggest there is generally a consensus that Airamp's safety culture has seen improvement. This opinion is stronger within senior and middle management employees than at operational level. There are strong ISC scores from Departments B and D, a medium score from Department A and relatively weak from departments C and E. The spread of opinion on the overall strength of safety culture, in points 3 and 4 matches the overall opinion on safety culture improvement. Points 5 and 6 highlight a disparity between management and departmental opinions on rule and SOP adherence. The relatively low scoring of Departments C and A are highlighted by d3SC, but their relative functionality should not be categorised without further qualitative analysis. Morrow, Koves, & Barnes (2014), identified in their extensive survey of safety culture that singular metrics do not effectively represent the collective safety performance of an organisation.

[80] Department E is based on only two returns, so the data was considered as unreliable.
[81] As per supra note 80.

The indications provided by d3SC at this stage of assessment do not necessarily indicate weakness in Airmap's safety culture but do invite further inquiry as to the dynamics which produce the scoring output. As Choudary *et al* (2007), Antonsen (2009), Nævestad, (2009) and Edwards *et al* (2013) have emphasised, it is imperative to determine what element of safety culture is being measured. They observed that safety culture surveys have often purported to have assessed the whole organisation's culture but are actually measuring component elements of safety culture. The crucial aspect of linking the measurements of safety culture with potential causal links (and ultimately potential liability) to safety performance requires further in-depth analysis into the nature of that relationship. It is the interaction between various cultural traits which determine subsequent human behaviour. Reader & O'Connor, (2014) followed this approach in their case study of the Deepwater Horizon accident. Utilising a human factors analysis process, they attempted to uncover the functional interactions on-board the rig and how crucial safety decisions were influenced by the broader organisational culture. Although safety culture has an increasing profile in the explanation of complex organisational accidents the legal standard of safety culture has to be linked with some elements of causal proximity to safety events.

5.4.1 Content Analysis A: Interviews with Three Senior Managers:

To explore the themes identified by d3SC and to evaluate the accuracy of the researchers d3SC based assessment of Airamp's safety culture, semi-structured interviews with three senior managers were undertaken. Across the three interviews the senior managers scored the overall accuracy of Airamp 3 as representative of company safety culture as 7.0 out of 10. Appendix E contains the full interview content and the numbered points below are the major themes identified across all three interviews:

1. Airamp's safety culture is improving.
2. There is a significant difference in operational and senior management perspectives on issues of safety management.
3. From a senior management perspective, rule breaking is a safety issue and needs to be addressed.

4. Effectively communicating safety message from senior management is crucial to safety culture improvement and bridging any ‘bottlenecks’ between head office and the departments.
5. Some safety improvements are perceived as cost-cutting measures by the workforce.
6. Cultural and certain personality differences are strong drivers to workforce perceptions. The strong influence of certain middle managers in the departments was emphasised.
7. Suspicions were raised by the interviewees about the motivation of some scoring; second guessing the true accuracy of some survey results was mentioned in two interviews.

As per point 1, all three of the senior managers expressed confidence that Airamp’s safety culture was improving but did not provide specific evidence as to why from their perspective they thought that was the case. All three also agreed with point 2–5 that there were issues of communication that needed to be resolved between senior management and operational staff. The phrase used to describe the impediment to open communication was ‘bottleneck’. The phrase was used six times during the interviews. Linking this observation to point 6, the phrase was associated with the crucial role of middle managers acting as a conduit of safety culture within organisations. The suggestion made at point 7, possibly links to this area. There was a reluctance to score higher accuracy scores that could have given a degree of affirmation to others’ opinion.

The emphasis in the interviews on the importance and strong influence on the effectiveness of safety culture being linked to operational supervision was noted by Morrow, Koves, & Barnes (2014). Reader & O’Connor (2014) emphasised the influence of on-site supervision. As an example, Vadrine and Kaluza, were the two most senior BP managers on board the Deepwater Horizon and were identified by the US legal system as the main protagonists of the critical decision-making path undertaken in the run up to the Deepwater Horizon explosion. Hopkins (2011) points out that even though more senior managers were on-board the rig when critical decisions were being made, the responsibility for safety critical decisions rested with the operational management team. The causal link is far more defined when decisions have direct impact and consequence

rather than those which exert broader but ultimately latent influence. A review of the case studies associated with corporate liability identified in *Tables 3-1 and 3-2* shows that the majority of the prosecution of individuals has been focussed on the on-site operational or middle-managers rather than the senior management of the organisation[82]. The role of senior management has received considerable focus in legal discussions of corporate liability, (Slapper, 1993; Steel, 2004; Wells, 2010) and in the influence on the quality of an organisation's safety culture, (Flin, Mearns, O'Connor & Bryden, 2000; Flin, 2007; Leveson, 2009). However, the mechanism of how senior management's influence is practically exerted has provided difficulty from a safety science and legal theory perspective.

5.4.2 Content Analysis B: Interviews with Departmental Managers:

The d3SC report had been with the department managers for three weeks before the interviews took place so sufficient time for the individuals to absorb the material. The d3SC process was again briefly explained and the paragraph describing the overall d3SC scoring of the total five departments was read through to refresh the manager's memory. The ethical guide and process was explained to the group, emphasising that they could withdraw from the process at any time. The group was then asked to call back with 48 hours at their convenience to discuss the report. The further phone call would allow individuals to give their opinion in confidence. Across the five interviews the middle managers scored the overall accuracy of Airamp 3 as representative of company safety culture as 7.6 out of 10. The full transcript of all five interviews are recorded at *Appendix F*. This subject of the interviews is an overview of the whole survey rather than an assessment of the accuracy of each manager's individual Department. The main themes identified through content analysis of the interviews were:

1. Safety culture in the organisation is improving particularly around reporting behaviours.

[82] The majority of the individuals in the following cases that were associated with potential corporate liability were middle or operational managers as opposed to senior managers of the relevant organisation: The explosion at Chernobyl, the sinking of the Herald of Free Enterprise, the explosion at the Westray mine, the Hatfield rail crash, Deepwater Horizon, the Fukushima nuclear accident, the SaberTech crash, Concorde crash at Paris, the Milan Linate collision, the CrossAir crash, the Skyguide air-to-air collision over *Überlingen*, the Gol/ Legacy Collision, the TAM crash at Congonhas, the Spanair crash at Madrid. See Tables 3-1 and 3-2 for further details on these incidents.

2. Rule breaking is a significant issue but more procedures are becoming an obstacle to safety and efficiency.
3. The influence of middle management has the biggest influence on safety performance above that of senior management.
4. More effective training is required by middle managers regarding risk, liability and safety management systems.
5. Accuracy scores were influenced by internal political issues within Airamp encouraging second guessing rather than purely individual opinion.

The improvement in Airamp's safety culture noted by departmental managers in point 1 reflects the collective senior management opinion. Point 2 was a consistent theme expressed across all five interviews. The departmental managers saw the imposition of more rules and SOPs (sometimes referred to as mitigations in the interviews) as counter-productive to safety and efficiency. Rule breaking was recognised as an issue that needed to be addressed but it was placed on an equal level of threat with over prescriptive procedure. Workarounds from rules and SOPs have long been recognised by safety commentators (Reason, 1990; Hopkins, 2002; Hollnagel, 2004; Leveson, 2004) and have traditionally been associated as symptomatic of poor or failing safety cultures. Grote (2007), suggests that this turmoil between risk ownership at operational level is indicative of an overly tight-coupling within the system design. Le Coze & Wiig (2013) suggest that the 'over-proceduralization' [sic] of safety processes is counter-productive to the effective functioning of complex safety-critical systems such as commercial aviation. This links with the importance placed by senior managers on the appropriate appointment and engagement of middle-management made at point 3.

Point 4 raises the issue of the appetite of middle managers for more risk based and liability training. This was perceived to be the remit of senior managers and yet from the perspective of the departmental manager they were more likely to have to account for any adverse outcome of their actions. d3SC did not directly identify this area as an area of development to bolster the resilience of Airamp from potential prosecution. A discrepancy was apparent between senior management and the operational workforce and safety and risk education could be considered as a mitigation to this difference in perspective. Lehmann, Haight & Michael (2009), considered the effect of workplace

safety training on risk tolerance and found little to no correlation between the two. They suggested the influence of non-workplace training and most importantly effective managerial supervision within a functional, open-reporting safety culture to have a greater effect on risk tolerance, and inferentially positive safety behaviours. Point 5, when linked with a similar point raised by senior managers that accuracy scores would not be raised to backup negativity about Airamp's safety culture. It suggests a potential lack of trust between senior and departmental managers and amongst departmental managers. This would again suggest further emphasis on direct operational management issues is a priority above the promotion of broader principles of safety culture.

5.4.3 Content Analysis C: Group Telephone Discussion with Managers:

The full transcript of the discussion is retained at *Appendix G*. The main issues identified by the researcher during the discussion were:

1. Work-arounds and procedural rule-breaking were a significant threat to operational safety.

2. Mitigations and new procedures were coming in but didn't address the issue. New work-arounds came with new procedures.

3. The group suggested that a risk-based approach to operational training and procedure was preferable to an overly prescriptive procedural approach.

The three main emergent themes which arose during the discussion re-affirmed many of the issues raised during the interview stage. The subject matter was kept deliberately open to minimise the influence of the researchers and senior management agendas. Differing attitudes to compliance were apparent and were differing risk appetites, but consensus was already in place between the attendees that whilst SOP and rule compliance remained an issue, the current senior management strategy of increased mitigation was not effective. Kringen (2013), noted that the experience of the Norwegian petro-chemical industry suggested that imposing best-practice safety culture principles into organisations results in varying interpretations of what effective safety practice actually looks like.

5.4.4 Professional Legal Opinion

As the purpose of this study is to establish a legal standard of safety culture for commercial aviation the opinion of legal professionals has been sought throughout the research process. Aviation and corporate liability are both relatively narrow areas of law so there is a thin strand of previous research to follow from any discipline. Two eminent barristers based in London did however agree to provide their considered opinion on the d3SC process and its practical utility within the professional legal field. Although the data was fully redacted from its original source Airamp was consulted before this phase of assessment was pursued and fully supported this phase of testing for d3SC.

The results of the d3SC trial were presented to two experienced London based barristers during May and June 2017. Both are Queens Counsel (QCs) and in current practice with specialist knowledge of corporate liability. The QCs were both individually asked to read a short report of the Airamp trial which included an introduction and explanation of the d3SC process. The initial research plan envisaged a short semi-structured interview however both barristers requested a period of time to reflect on the data before providing their written opinion. Both assessments are entirely independent with no possibility of cross reference. Each of the barristers were asked to consider the following questions:

1. Should a fatal accident occur, would the state of Airamp's safety culture, as described in the report, make them potentially vulnerable to prosecution under the CMCHA? (See CMCHA sect. 8.2/8.3).

2. To what extent, in your opinion would the process of self-assessing safety culture using this process, d3SC, provide a defence of due diligence?

3. Should a conviction under the CMCHA occur, would an organisation’s participation in an assessment like d3SC, perhaps regarded as a form of restorative justice, potentially mitigate any penalty?

4. Finally, what potential utility do you see for the d3SC process?

5.4.4.1 First Legal Opinion of d3SC

Robert Lawson QC
"The d3SC assessment process is undoubtedly a useful tool to help gauge, with some degree of objectivity, the state, quality and pervasiveness of an organisation's safety culture; and to assist that an organisation to continue to develop and enhance that culture. To do this is to embrace a just culture truly. At the level of generality, the utilisation of this process is likely to assist in protecting an organisation from successful prosecution under the Corporate Manslaughter and Corporate Homicide Act 2007 in the subsequent event of a relevant death, but only if any negative lessons revealed by it are heeded and subject to reasonable remedial action – if they are not then that would, conversely, be an aggravating factor. However, it is difficult to descend from this to opine on the actual utility of the d3SC process for any particular organisation in any particular case. This is for the simple reason that prosecutions are fact specific and, as history too often shows us, the factual circumstances which actually give rise to a death are invariably both complex and difficult to foresee or predict. For this reason, one cannot say with any real confidence whether or not Airamp's safety culture as revealed by this report leaves it vulnerable to prosecution should it have the misfortune to suffer a relevant death at some point in the future. Whilst its safety culture is revealed to be relatively strong at the top, it seems more patchy as one descends the hierarchical ladder. The disparity revealed is something the senior management must take steps to redress, and to ensure are redressed, if Airamp is to be able to draw comfort from having undergone this process. It must be congratulated for embarking on this journey, but reminded that ALARP is a moving target and a just culture therefore recognises that the journey is a never ending one".

5.4.4.2 Second Legal Opinion

Queens Counsel Barrister's name withheld on request
"In essence, inter alia: no single item or individual piece of information would dictate to a jury (inquest or criminal) what is the correct verdict after hearing a summing up from a Judge or Coroner. The test of senior management failure is still in its judicial infancy- items of alleged neglect can be aggregated by the Juries and Judges depending on the facts of the case in hand. Individuals are increasingly being prosecuted for health and safety and or manslaughter. Juries will be guided by the judicial figure on their ability to gauge the general culture of an organisation from the evidence including how far short they fell with regard to existing guidance and legislation and arguably any internal or external reviews including insurance. It is therefore arguably pertinent and apposite to look at this type of research to reveal and review what the general current status and trends and themes of the organisation is alongside other items of evidence, i.e. this in itself is only one layer of the required information. This information would not be protected by legal professional privilege

and could be used by investigating authorities. It would depend on many other factors whether it could be used in mitigation but possibly in certain circumstances it might be of use depending on what were the actual facts. This would also obviously depend on what the research had revealed and how quickly the organisation had reacted to the information being indicated. In conclusion although I am by no means an expert at all (!) on the computer side and have only read this document - this looks like very worthy and important work that should be continued.

5.4.4.3 Content Analysis of Legal Opinions

The two barrister's answers were analysed and compared. The barrister's answers to the questions reflected thematic consistency as to the legal implications of conducting a d3SC survey within an organisation engaged in a safety critical activity such as commercial aviation. The following themes emerged:

1. There is value in the utilisation of d3SC or other assessment tools which can periodically assess the nature, emerging patterns and quality of an organisation's safety culture.

2. The utility of d3SC could be a positive influence in contributing towards a defence of due diligence. This is based on the presumption that the findings of d3SC or any similar mechanism is acted upon in a timely manner.

3. D3SC could not provide a predictive level of corporate liability with any degree of confidence as each case is highly contextual. Only reference to the facts of a particular case could determine liability.

4. This type of information is not protected by professional legal privilege. As such an organisation which engages in this or similar assessment must be prepared to act on the findings. Not to do so could leave the organisation's data vulnerable to use by a prosecuting authority or complainant party should it have the misfortune to suffer a relevant death at some point in the future.

Point 1 legitimises the link between safety culture and corporate liability as recognition by the legal profession. Safety culture is certainly not a term of art from a legal or safety science perspective, having attained no precise technical definition. However, *Tables 3-*

1 and 3-2 describe numerous high-profile cases where safety culture, or organisation attributes associated with safety culture have appeared. The utility aspect of d3SC made at Point 2 reflects the point made by Gobert & Punch (2003) and Pinto & Evans (2008), that to promote best practice within an industry, a defence of due diligence should be made available; due diligence being the antithesis of fault. Although Simpson *et al* (2014) have questioned the rationality of corporate behaviour and Mishina *et al* (2010) have described the often-complex and occasionally counter-intuitive motivators behind corporate malfeasance, there is a legally recognised benefit to corporate risk management strategy in undertaking regular d3SC assessments. The benefit is of course based on the premise that appropriate and timely mitigation to any identified issues is undertaken, as was witnessed in the case of *R v MNS Mining Ltd* [2014].

The lack of predictive capability of d3SC is highlighted at point 3. This lack of predictability has two basic sources. The first is that the law concerning corporate criminal liability is in many ways in its infancy (Forlin & Smail, 2014). The legal system is a conservative and reactive animal by any standards and the nature of the corporate body provides a particular challenge to the rules of causation by which it must abide (Johnson, 2008; Almond, 2013).

Point 4 reminds any potential user of processes such as d3SC or indeed any assessment of the effectiveness of a corporation's safety and risk management practices that it creates potential evidence. If the data output of this type of survey is acted upon, then it could be a positive influence as described in point 2. If it is not acted upon in an appropriate manner, then then it remains as a potential piece of incriminating evidence.

5.5 Discussion

5.5.1 Content Analysis of Airamp Interviews

The Airamp survey was carried out to assess the safety culture of a small to medium sized aviation organisation that wanted to improve and strengthen its safety culture. By comparing the output of a process of content analysis over the interviews with senior and departmental managers four main themes were predominant and invite further discussion:

1. Senior Management Commitment: There was a difference in perceptions between senior management and the operational staff as to senior management's commitment to safety matters. This was initially indicated by differing d3SC scores of WBL between Airamp 1 and 2 and Airamp 3. This was verified during semi-structured meetings A and B.
2. Alignment: There were areas within the organisation where the senior management message about safety matters was not effectively communicated to operational staff, referred to in the interview stage as the 'bottlenecks'. This was indicated by differing d3SC scores of WBL and correspondingly low EAC scores between Airamp 1 and 2 and Airamp 3. This was verified during meeting A.
3. Rule-Breaking: There was an identified phenomenon of rule breaking and SOP breach throughout all three Airamp surveys recognised to varying degrees at all levels of the organisation. This was reflected by marginal or low scores for SBR except in the score for Department D. This was verified during meetings A, B and C with Airamp managers.
4. Over-Proceduralisation: Department managers expressed a concern that the over-proceduralisation of safety related activities was inhibiting dynamic risk assessment during operations. This was not identified by the d3SC output but identified in meetings B and C.

The overall thematic output of the survey as described below in *Figure 20* revolved around the relationship between senior and middle management levels. The diagram reflects the four points listed above and the d3SC value most closely associated with (but not exclusive to) each finding. Below each description of the finding is a list of which interviews from which the perspective was evidenced. The contrast in the perspective of those at senior management and board level and the reality of the middle manager role was recognised by the then head of the UK's AAIB, Ken Smart in a speech to the Royal Aeronautical Society, "There is no airline in this country that does not have a corporate mission statement to the effect that 'safety is paramount'. Those at board level totally believe in this concept but it is not unusual for the message to obtain a subtle twist usually in the area of middle management where the delivery pressures are most acutely felt. In the middle tier of management, the message can often be translated as yes safety is paramount as long as the aircraft is delivered to the line in time to make the schedule",

(Smart, 2004:4). This description is complemented by the observation of Airamp manager A2, who stated, “Things are improving. We do however, have a more flowery description and view of safety and risk than the average guy on line”.

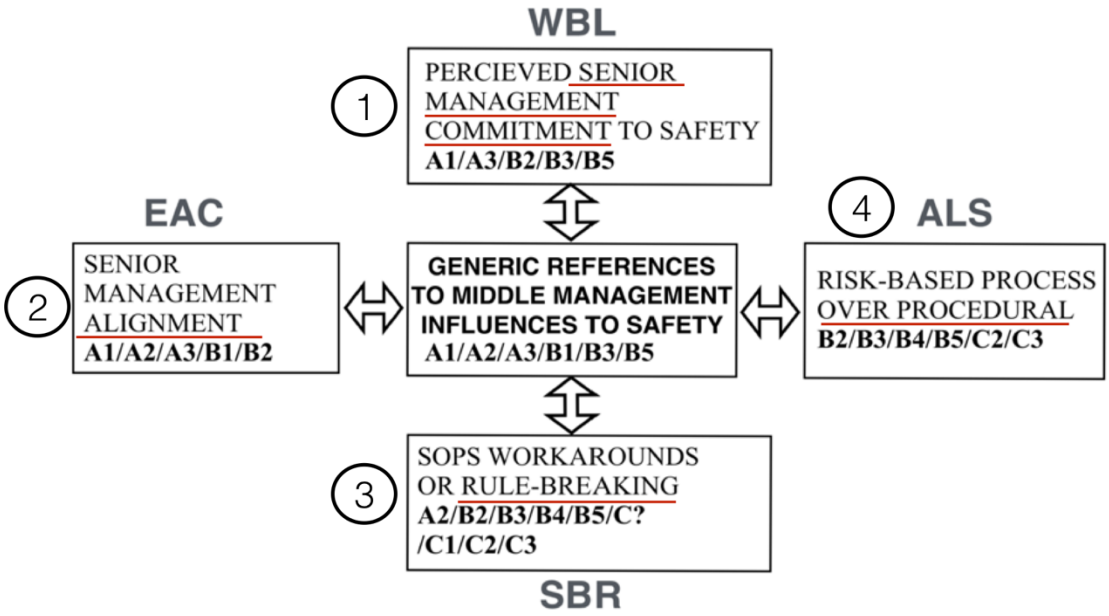


Figure 20 A pictorial description of the central themes of middle management influence on Airamp’s safety culture.

5.5.2 Guarding the Senior Guards

Although every effort was made to maintain objectivity throughout the process of content analysis, the triangulation process was predominantly filtered through the interpretation of Airmap’s senior management, natural bias from a perspective of senior management could be anticipated. There would appear to be various perspectives within the organisation on senior management commitment to safety and through the interviews, various interpretations of how accurately d3SC represented some of Airamp’s departments. As the individual d3SC scores were not presented to the individual department managers, a further level of quantitative analysis of the accuracy assessments of the regional and senior managers was considered an appropriate triangulation process.

The assessment was intended to assess consistency of scoring between each manager’s assessment of each department’s d3SC score and analysis. For convenience, the accuracy scores for each interview with a mean score is presented below in *Table 6-1*. The table

allows a comparison between each department and each interview for accuracy scores. The mean accuracy by each department shows an interesting correlation with the ranking of the d3SC overall output. The d3SC output for each department were ranked in order of the Potential Corporate Liability (PCL) score, it shows for this assessment, that the higher the safety culture was scored, the higher accuracy score the department was given by the senior managers.

Table 5-1 A comparison of d3SC scores with senior management validation scores.

AIRAMP 3 Senior Management	SENIOR MANAGEMENT VALIDATION INTERVIEWS SCORES						
	ALL DEPTS	DEPT 3A	DEPT 3B	DEPT 3C	DEPT 3D	DEPT 3E	MEAN ACCURACY BY INT
INTERVIEW 1	6	6	8	5	9	7	6.8
INTERVIEW 2	7	7	8	3	8	6	6.5
INTERVIEW 3	7	8	7	7	9	8	7.7
MEAN ACCURACY BY DEPT	6.7	7	7.7	5	8.7	7	
D3SC SCORE RANKING	N/A	3	2	5	1	4	

The lowest individual scores for accuracy focussed on the assessment of Airamp 3C. This department seems to have been an issue of some concern to corporate management. The relevance of the score was brought into question during the senior management interviews. It seemed that the department had had something of an interesting history *vis-à-vis* the head office of Airamp. Many of the comments reflected strong opinions about the department:

C1: "I'd say its accurate in some parts. There was a real issue with '3C'. But I don't see a lot of what's described."

C2: “If it is as bad as this then we should be seeing some evidence of systems break down, somewhere. I do accept there are areas of break-down in communications between senior management and staff.”

C3: “Okay, This department really, really, strong bunch of characters. Almost to the extent that the tail wags the dog. Very opinionated. All it takes is one thing.”

5.5.3 Unconscious Bias or d3SC Bias?

This correlation could suggest a form of unconscious bias amongst senior management in assessing accuracy of the safety culture scores; possibly as they assume responsibility for the strength or quality of departmental safety culture. It brings into question issues of subjectivity when using semi-structured interviews purely as a method of triangulating data from semi-statistical surveys such as d3SC. Although the content analysis of the intervews provided a rich source of information through the comments (explaining why certain scores were achieved), a more objective validation method could be considered rather than the single and simple scoring system used in this study. This issue is extensively discussed by Ritchie *et al* (2013). Whilst the intuitive reasoning for validation is perhaps confidence in data interpretation and accuracy, a more important function can often be an increased depth of understanding through the discrepancies between differing data collection methods.

Another explanation could be that the algorithm itself is not describing the safety culture with sufficient accuracy. The calculations are all related but predominantly weighted from the perception of the level of commitment from senior management. The departments are geographically separated from the head office with sometimes only occasional direct communication between senior management and the operational workforce. Within the sub-culture, an effective but independent safety culture could function. Its d3SC score would then be negatively skewed by a low WBL score. However, if the overall d3SC assessment is considered, Airmap 1 and 2 in which senior and middle managers were the subjects showed significantly more positive d3SC scoring than Airamp 3 which included line operators. This suggests a positive bias recorded a higher d3SC score by more senior managers than those at the operational and departmental level; in effect, the differentiated values and attitudes of senior managers could constitute a further Airamp sub-culture.

This situation draws some comparison from some of the features identified in the case studies described in *Appendix D*. The strong influence of personalities, particularly in middle management spheres was recognised in initial d3SC trials in *Appendix C*. According to Hopkins (2014a) the inability to communicate an accurate safety culture message was cited in the BP Deepwater Horizon report and shows some similarity in the d3SC output. A similar lack of communication was a feature of the TAM crash at Congonhas Airport. If a company allows operational risk standards to fall below an acceptable level then as in the Hatfield rail crash in the UK, criminal prosecution can follow if that characteristic can be linked to accident causation. The discussion in the literature review suggests that may not be a particularly high legal bar in the aftermath of an accident. That is particularly the case if evidence is obtained that there is prior knowledge within senior management circles that problems were apparent. These comparisons do not imply Airamp's conduct could be compared with these high-profile case studies. However, having identified an area of interest, even if no consensus exists as to the nature of the issue, further investigation is necessary to develop a defence of due diligence.

5.5.4 Manage Culture: How?

The subject matter of this interaction between senior and departmental managers predominantly focussed on how safety should be managed at operational level. A constant theme in the Airamp surveys was the senior management focus on rule breaking as an operational threat. Middle and departmental management and to a lesser extent recognised the issue as an area to be addressed but differed in their opinions on how best to improve the situation. Conducting surveys with their Airline Safety Culture Index, (ASCI) Edkins and Coakes (1998) concluded the achieving positive safety culture was harder to achieve in larger organisations and according to Hudson, (2007) larger organisations tend towards calculative safety cultures. The key issue referred to in both these studies in related to the ability of effective communication of safety messages rather than the physical size of the organisation.

Airamp is not a large organisation but does have geographically dispersed departments. This in itself is not a unique or even unusual organisational characteristic. Safety critical industries such as nuclear power stations, oil rigs or those with numerous airports all

manage geographic separation. The differential of Airamp to other organisations is the strength of cultural association with their place of work accentuated by the typical longevity of its staff at these locations. The departments recruit locally and staff retention periods are generally very high. Fang & Wu (2013) noted the rapidity with which sub-cultures developed within project life spans. They identified changes in the group's focus rapidly internalised towards the project's needs rather than their original organisation's priorities. The interviews suggested that within Airamp there are strong and recognisable departmental cultures at each one of the departments and each has developed a particular approach to departmental safety management.

5.5.5 Culture versus Cultures

The net effect of this separation is a susceptibility to the emergence of sub-cultures which dominate local opinion at departmental level, (Guldenmund, 2007). Indicated, as an example by the strong independence of Department A in their interpretation of senior management 'interference' of local affairs. Similarly, the contrasting elements in the d3SC assessment of Departments C and D suggest very different cultural traits. The Airamp data would support the theory that a distinct common set of assumptions and values are experienced at local rather than senior management level. Brooks', (2008) ethnographic study of a small to medium size company observed the direct influence of strong negative and personality led cultural influences were more efficiently communicated at the micro level. This finding was supported by Morrow *et al* (2014) and suggests whether the influences are positive or negative, proximate managerial influences are more direct, focussed and powerful than the espoused values and attitudes of senior management.

The influence of certain strong personalities at local management has been recognised and addressed by management both at senior and local levels. d3SC identified positive and negative influences from middle management but the strength of this impact was only gathered during the triangulation process of semi-structured interviews. Schein (1996) described an organisational culture as a collective of sub-cultures suggesting the interpretivist and functionalist perspectives could be considered complementary rather than mutually exclusive. Schein (2017) noted that when we observe behavioural characteristics we do not know whether this is representative of the cultural landscape, or

to use Edgar Schein's language an artefact of the predominant culture. A deeper inquiry is necessary to place these observations into a broader perspective. To manage and influence, breaking down the overall structure into their component parts is an important step towards establishing the significant strengths and weakness of an organisation. This has been an aim of the development of d3SC.

However, the ability to conceptualise an organisation at differing and appropriate levels allows the identification of potential causal patterns and potential organisational liability. The emergence of sub-cultures is a recognised characteristic in organisational assessment, but the aggregated assessment of these sub-cultures can lead to a rather misleading picture of the organisation's true nature, Kringen (2013). Based on the organisational culture model of Schein (1996), d3SC is designed to illustrate various perspectives of an organisation's safety culture. Schein described the requisite elements for a collective, or group to be considered as a culture:

1. That common assumptions underline the essence of the culture.
2. The espoused values that often reflect what any group wishes ideally to be and how it wants to present itself to the outside world.
3. The day-to-day behaviours that represent a complex compromise among the espoused values, deeper assumptions and the immediate requirements of a given situation.

To this extent, Airamp could not be described as having single 'a safety culture' but a collective of sub-cultures with various levels of commonality with the values and assumptions of senior management and company policy. The behaviours described by Department A suggest an alignment to local common and accepted practice rather than a generic Airamp culture. This perspective was echoed by Airamp senior manager A3, "The operational frontline and senior management trying to get the communication lined up particularly with the topography of the organisation and the community cultures are different. There is a completely different view of life between those in the north and south and west. They're all different". This perspective aligns with that of Cooper & Phillips, (2004) who considered the departmental level an appropriate level of resolution with which to research organisational culture.

5.5.6 Senior Management and Bottlenecks

The power of a single personality to influence both positive and negative safety cultures was a consistent theme which ties to this idea of local rather than central influence. To use the words of senior manager A3 noted during the individual interview (*Appendix G*), "It has crystallised my perception of the bottleneck. The latent issue is with the bottle neck. Different place cultures not just safety culture". An overview of Airamp 1 and 2 from a managerial perspective describe an organisation with a reasonably strong and improving safety culture. It has made significant efforts, stemming from individuals within its senior management community to reform what was perceived by some of its workforce as a blame-culture. This is evidenced by reporting levels which have improved significantly with increasing confidence in the justness of Airamp's safety management system. The Airamp 3 assessment did however observe that there is scope for further improvement to develop consistent standards and safety performance between differing departments. There are differing perspectives on the level of senior management commitment to safety. Only two of the five departments agreed that senior management commitment was high. The influence of senior management commitment to safety has been emphasised by *inter alia* Leveson (2004, 2009, 2011b), Hopkins (2006), Flin, (2007) and Guldemund (2007), this suggests safety culture research has favoured a top down approach.

Whilst evidence from this study does not directly contradict this perspective, the Airamp assessment did emphasise the influential significance of what senior managers A2 and A3 referred to as 'bottlenecks'. The importance to senior management of driving strong and direct lines of communication is described during the interview by manager B3, "Really need to align senior management attitudes with the guys out on the line. That's the thing." The safety culture of an organisation is highly dependent on the authentic commitment of senior management to issues of safety but how that message is conveyed and locally translated into safety promoting behaviours is predominantly dependent on the proximate influence of local supervision.

5.5.7 Work With or Against Sub-Cultures?

Having identified differential attitudes between senior and departmental attitudes, the question arises as to how an organisation such as Airamp can manage its safety culture

towards improvement? Perhaps because the phenomenon of sub-cultures has been described in accident case studies the term hold negative connotations. Both Reiman & Oedewald (2007) and Morrow *et al* (2014) took the view that differing cultures can perform equally well in terms of safety performance. A common observation from the majority of sources in Airamp described an improving safety culture even where differences of opinion arose on how to progress. Schien (2017) commented on the use of existing cultural patterns within an organisation, he comments, "In most organizational [sic] change efforts, it is much easier to draw on the strengths of the culture than to overcome the constraints by changing the culture".

5.5.8 Limitations of Airamp's d3SC Survey

As d3Sc was is still in a relatively early stage of its design process this survey is the largest sample group yet undertaken by the d3SC process. There are several limitations in this process which may have some bearing on the process output:

1. The sample groups were relatively small. A total sample of 43 is not insignificant, however, given the geographic separation of the various departments it is significant when one department (E) only produces 2 returns. This set of results was included but should be considered unreliable.
2. Some of the data (Airamp 1 & 2) was collected as part of safety seminars with other managers and senior managers present. This environment could affect the credibility of the data, given the weighting and sensitivity of the subject matter.
3. There was no control of the environment in which the survey was completed for Airamp 3 which was conducted by e-mail. This left no effective way of ensuring the contributors had privacy.
4. There was a significant and unavoidable time lag between Airamp 1 and 3 and then again until the final validation interviews took place in April and May 2017. This became apparent during the interview stage when several managers referred to significant cultural characteristics in the past tense.

5. The use of semi-structured interviews to validate the output of d3SC proved to be a rich data source but for further studies, an alternative, possibly mixed method triangulation technique may have to be considered.

5.6 Conclusion

The findings and recommendations of this report has in accordance with the initial research agreement been passed to Airamp for their due consideration. The report illustrates the dilemma of disclosure faced by organisations in the self-assessment of safety culture. By delving into the details of how safety and risk is managed within its own organisation, a significant amount of detail is highlighted which may never have appeared in the normal course of safety management. The potential risk from not addressing this issue in the management of safety is that some organisations and particularly those which consider improvements are needed, could inhibit self-assessment of safety critical activities. The inhibition of open-reporting systems in aviation has been recognised as a significant restriction on future safety developments (GAO, 1997; FSF, 2010). The approach taken in jurisprudence, highlighted by Hart & Honoré (1985) deliberately maintains ambiguity within the highly technical yet highly ambiguous language of judicial opinion. One could suppose the logic of this ambiguity encourages organisations to steer comfortably away from potential liability, but it may also have the undesirable effect of encouraging ambivalence to corporate criminal action.

6 DISCUSSION

6.1 Introduction

This chapter will consider the initial purpose of this study against the research output. After a brief review of the purpose of investigating a legal standard of safety culture, the overall output of the Airamp study will be compared with relevant literature. Given the contextual nature of the concept of safety culture, some potential directions for appropriate management approaches will be discussed. Finally, in considering these strategies in the wider perspective of industry initiatives, some potential ideas for future legal strategies to encourage the effective management of safety culture within commercial aviation will be proposed.

6.1.1 The Purpose of the Thesis

The current situation in defining a legal standard of safety culture in commercial aviation leaves something of a gap between unspecified standards of safety and risk management. According to Townsend (2013) the transformation from prescriptive to goal orientated regulation has encouraged the UK's Health and Safety Executive to increasingly rely on the criminal justice system to improve compliance rather than directly engaging its own resources. As the highly regulated commercial aviation industry moves towards its own stated aim of performance-based regulation, it leaves a potential pitfall for an operator culture that has become over reliant on specified standards, (CAA, 2014).

If the goal of performance-based regulation is to minimise the loss of life through air accidents, the current state of affairs in this ultra-safe system leaves little room for improvement in terms of conventional metrics of safety in commercial aviation. However, if the goal is to demonstrate continuous improvement to mitigate the risks from rapid expansion and increasing system complexity, then new and appropriate management tools are necessary to promote further system resilience. These safety management tools need to encourage safety critical organisations to move away from the acceptance of epistemic uncertainty and embrace proactive safety management. This study attempted to evaluate the feasibility of this approach by illustrating the causal link between safety culture and corporate criminal liability.

6.1.2 The Purpose of d3SC

6.1.3 The Risks of Over-Simplification

One risk identified in the thesis is that weaker areas of organisational culture can be diluted within an overall simple scoring mechanism. Without breaking down the Airamp d3SC survey into its departmental elements little could be determined about the mechanisms of organisation. Only when departmental and hierarchical comparisons could be identified, did the differing perspectives of sub-cultures and the proximate influence of departmental management emerge as safety culture characteristics. The 'aggregation' of outputs from previous safety culture surveys has been recognised by *inter alia* Wiegmann *et al* (2007). It may go some way towards the explanation of why some safety culture surveys have found little correlation with safety performance. If we consider the dynamics of Airamp, the significance of d3SC's representation of the collective output of the organisation, there would be little meaningful explanation of safety related behaviours. Even with extensive studies within relatively homogenous environments such as that undertaken by Morrow *et al* (2014), the output based on simple metrics give little understanding of how and why safety cultures function. Noort *et al* (2016) reported a relationship between Hofstede's UA (Uncertainty Avoidance) value and safety behaviours but these analyses give little indication on how to promote managed improvements.

Another significant risk is that areas of relative weakness are left to be 'discovered' after an accident. In Appendix D, the causal explanation of a number of high-profile accidents were interpreted through a retrospective d3SC analysis. The majority of examples demonstrate extensive safety culture weakness which would of course be expected as all examples were high profile accidents. These accidents had attracted considerable investigative resource and therefore affording focussed attention on organisational influences (Hopkins, 2006; Hollnagel, 2014). The issue for organisations seeking to diligently manage their potential liability risks is that prosecutorial investigation will not provide evidence of an aggregate assessment of safety culture, but deliberately expose the weakest areas and use that evidence to infer deeper causal associations within the organisation.

6.2 Potential Future Strategies

Within Airamp, the d3SC assessment highlighted two differing opinions of how to address a consistent issue of rule breaking or procedural work-arounds. Whilst senior management consistently focussed on the negative influence of SOP breaches and rule breaking, departmental management consistently commented on over-procedural operational tasks. Department managers suggested a more risk-based approach to training and operational management. In their opinion, this would be more appropriate for the real-world operational environment rather than more rules and procedures. In the interviews and group discussion, departmental managers felt that more rules and procedures simply resulted in more work-arounds rather than appropriate mitigation. The opinion of departmental managers is succinctly described by manager B5, "If there is an attitude of high risk taking then that will filter directly down to the crew. The most important job is middle management and their opinion; their culture directly affects the operational culture".

6.2.1 Loose Coupling and High Reliability

Tight coupling was a term introduced by Perrow, (1999) describing a feature of organisational process that invoked inflexibility in safety and risk management. The acceptance of variable degrees of tight coupling in contrasting approaches to uncertainty management were considered by Grote (2007). She identified two main strategies: that of minimising uncertainty and coping with uncertainty. Strategies to minimise uncertainty are often associated with organisations that are highly regulated and safety critical. They tend to be process driven in their management of risk. Commercial aviation has traditionally fallen within this description but must now adapt to the new challenges of performance-based regulation. Grote aligns the mitigation of uncertainty with traditional prescriptive regulatory strategies and highlights the issue that prescriptive compliance cannot cope with rapid adjustment and increasing levels of complexity. In a contrary approach, accepting operational autonomy invites the vagaries of variable human performance into critical processes. Grote concludes that a combination of these approaches applied to the context of immediate organisational risks was an appropriate strategy. The suggested moderating factor to coordinate autonomic actions whilst maintaining superordinate goals is organisational safety culture.

Having identified the bottleneck department managers of the Airamp assessment as significant influencers of safety culture it would seem an appropriate organisational response to engage with these individuals. Schein (1992) describes culture and leadership as two sides of the same coin. Further research into the mechanisms of safety culture warrant consideration of how safety management leadership styles control the dynamics of organisational interaction. Reference to the work of Bass (1990) and his discussion of the differing mechanisms of transactional and transformational leadership styles could give insight into further potential strategies to promote the enhancement of safety culture.

6.2.2 Uncertainty and Due Diligence

Grote's (2007) paper goes on to describe a contextualised approach to safety management is the optimal approach. High Reliability Theory, HRT suggest a similar level of flexibility with which an organisation can react to new and emerging threats is the key to resilient safety performance. Certain tasks require contextualised approaches in complex systems. Hollnagel (2014) supports this view in tapping into the positive aspects of safety culture rather than attempting to impose a singular perspective. The crucial element in maintaining a safety culture influenced approach to safety critical activities is the due diligence with which the individual, or group or sub-culture approaches risk. If an organisation wants to develop a defence of due diligence, then it must seek to establish that due diligence is actioned at all levels of the organisation rather than overly focus on compliance. An organisation has to demonstrate a requisite standard of safety operation and not just a requisite standard of safety management.

6.2.3 The Diligent Management of Safety Culture

The output of the d3SC safety culture assessment described Airamp, as generally strong but with some areas that could be improved. Safety and risk managers have to consider what appropriate measures would constitute and maintain a pre-emptive defence of due diligence, should an accident actually occur, but that value judgement has to made within the context of their organisational environment. The legal maxim of *sine qua non*, or 'but-for' the involvement of senior management to establish corporate liability, is a requisite element in attributing liability under the CMCHA (Wells, 2010), however the causal relationship has only to be established intuitively to a jury not scientifically to organisational theorists or safety experts. Prosecutors only have to establish an element

of relatively weak safety culture. A safety culture that showed significant deficiencies could be described a NESS, a necessary element of a set of jointly sufficient conditions (Mackie, 1980). However, one that had recognised deficiencies but within an organisation that could establish it had made significant improvements is in a significantly more defendable position.

The literature review described a progression in the perception of safety culture towards a causal element in organisational accidents. This progression changes the type of uncertainty associated with its causal role. To use the risk phraseology adopted by Paté-Cornell (2012), improving knowledge of safety culture moves the concept away from the concept of aleatory uncertainty towards that of epistemic uncertainty. In effect, its influence cannot be predicted but can increasingly be estimated. This differentiation invokes issues of causal liability in this relatively new and untested area of law. This conceptual evolution re-enforces the important point made in the comments made by both legal experts, that for organisational risk management, senior executives should be constantly kept informed as to the nature of their organisation's safety culture and that proportionate and timely measures of necessary improvement are acted upon. Schein (2017) emphasised this particular point, "The bottom-line for leaders is if they do not become conscious of the cultures in which they are embedded, those cultures will manage them. Cultural understanding is desirable for all of us, but it is essential to leaders if they are to lead." That simple and pragmatic strategy underlines the basis of a defence of due diligence.

6.3 Conclusion

The output of this study would suggest that the contextual nature of safety culture is one which could better align with performance based rather than prescriptive regulation. The varying approaches to safety and risk management aligned with the cultures of Airamp's department and managerial strata suggest that a prescriptive approach would not allow the requisite latitude of values and attitudes. This presents a difficult and delicate balance for Airamp safety managers and one which has little to no regulatory mandate. Kringen, (2013) highlights that experience from the Norwegian petro-chemical industry produced a situation where the regulator and operator's interpretation of effective safety culture significantly differed. However, this situation is perhaps not one which prohibits effective safety performance provided some common foundations and basic principles are not distorted.

Safety culture regulation might consider a similar approach to the one taken by the regulatory and criminal legal system to risk management. A legal standard of safety culture is an uncertain area on two counts: there is very little case law to guide the industry and considerable uncertainty as to how safety culture is manifest in the causation of accidents. However, as discussed in the above section, progressive knowledge which associate the causal role of safety culture with safety performance might now be said to afford a differential between an organisation that ought to have known and those that could not have foreseen an accident[83]. In just the same way that risk can be estimated as a relative product of severity and probability, legal attribution could be considered as the sum of its associated attributes. Making estimates to the level of risk is not a precise science, but without being overly prescriptive, a basic tenet of health and safety law proscribes that not to undertake a risk assessment in a safety critical environment invites criminal sanction to the malfeasant organisation (Townsend, 2016).

Regulation and criminal law overlap in the generic area of health and safety, risk management and regulatory compliance. A legal standard of safety culture could exist in any one or all of these areas of safety management, however the way it is brought into

[83] For further discussion see *R v Tangerine Confectionery Limited* and *R v Veolia ES (UK) Limited* [2011] EWCA Crim 2015 were heard simultaneously by the Court of Appeal as both cases were concerned with the same area of law; the requisite level of foreseeability in risk assessment.

common use in commercial aviation may require differing methods to those employed by traditional regulatory or deterrent tactics. Leveson, (2011c:62) argues that "Blame is the enemy of safety". It might be also argued that the absolution or the dilution of responsibility is equally a threat to safety. Some form of penalty for insufficient or inappropriate management of an organisation's safety culture would seem an inevitable consequence of the progression of safety culture towards a legal standard. In any case a successful introduction to commercial aviation will require an appropriate balance of education, encouragement and coercion. The UK's HSE introduced a 'fees for intervention' regime to mitigate regulatory cost and improve safety standards. Under the scheme a non-compliant entity has to cover the cost of intervention by the regulatory authority. Aviation regulators could utilise such a scheme to introduce the management and development of appropriate safety culture attributes rather than proscribe a singular model. Another alternative could be a 'truth or consequences' approach to promoting self-regulation of safety culture. If regulatory mandate simply required the self-assessment of organisational safety culture then the knowledge of potential periodic access to that data by the regulator and definite scrutiny of the same data by criminal prosecutors following an accident, could provide a suitable balance.

7 CONCLUSIONS

7.1 The Initial Hypothesis

The mechanisms of corporate safety culture and corporate criminal liability have become sufficiently aligned to enable the development of a practical risk management tool which could enhance safety culture and mitigate the impact of a prosecution for corporate manslaughter.

The original area of research identified in this study was to research the potential of a legal standard of safety culture for commercial aviation. The primary research question was: To what extent can legal standards of safety culture be identified and applied to the field of commercial aviation? This area was considered of particular interest as it included a number of developments in corporate liability, safety science and organisational risk management practice. From initial research, it was hypothesised that the concept of safety culture constituted a new development in legal causation and safety management which held considerable potential. Against a background of increasing criminalisation of accidents across commercial aviation and other industries, understanding this phenomena in a legal context was considered a worthy area of research. The research questions of how this variously defined construct of organisational and safety theorists could be employed to improve the safety management of increasingly complex and high technology systems are grouped into four research objectives. These objectives and questions are listed below with a brief description of how this study addressed each area and what conclusions were drawn.

7.1.1 Objective I:

To consider the extent to which the mechanisms of corporate liability and corporate safety culture have become aligned.

The literature review and the case studies listed in *Tables 3-1 and 3-2* suggested an evolution in the focus of corporate liability. The change has been particularly noticeable in the way in which the law of corporate liability has increasingly focussed on the influence of senior management on organisational safety performance. This relationship has proved to be complex and has not subscribed to traditional models of legal liability (see *Table 2-2*). The law has recognised the corporate body as a separate legal entity for

centuries, but established notions of liability have their roots in Western neo-liberal principles of personal responsibility. Through the majority of the twentieth century, these principles have been reflected in the requirement for corporate liability to have direct causal links with the actions of senior management.

The emergence of safety culture as an explanatory concept has in some ways overtaken the debate on the nature of its conceptual construct. It has proven to be a useful descriptor of organisational failure given its homogenous nature but has seen less progression as a tool of risk and safety management. But it is however the apparent conceptual shortcomings which align the concept of culture with the concept of causation. Both concepts are extensively used as descriptors, both can be interpreted to suit socio-political motives and both concepts face resistance to the constraints of regulatory definition. The debates on causation stretch between positivist and interpretative approaches to law whilst that on organisational culture between functional and ethnographic perspectives. Within these debates, some consensus becomes apparent that organisational safety culture can be described as a necessary element of a set of sufficient conditions (Mackie, 1980). In effect as well as being a useful descriptive concept of organisational failure safety culture can be seen as a recognised form of legal causation.

7.1.2 Objective II:

Develop a self-assessed, evidence-based risk management tool, with which organisations can enhance their safety culture as a pre-emptive defence against a potential prosecution of corporate manslaughter.

There have been numerous suggestions by legal commentators for the formal recognition of a defence of due diligence (Wells, 1996, 2001, 2010; Gobert & Punch, 2003; Hopkins, 2005; Pinto & Evans, 2008; Almond, 2013). The theme of these arguments is essentially to provide a corporate objective towards best practice in matters of safety. The grounded theory process described in Study One produced a prototype model. The model's nine attributes align with much of the literature's suggestion that multiple levels of resolution are required to capture the overall nature of an organisation's culture whilst having the ability to dig deeper into the broad elements of ethnographic features and avoid misleading aggregation (Martin, 2001; Wiegmann *et al*, 2007; Gioia *et al*, 2013).

The d3SC model measures the quality of safety culture at organisational level to allow inter-organisational and departmental level comparison in order to understand internal organisational dynamics (Cooper & Phillips, 2004). Further manipulation of the data can assess hierarchical differences. The more complex issues the model had to represent were causal concepts. This was partially due to the nature of the data sources. Whether a formal accident report was referred to or that of a legal case, they each perform as specific explanatory role. This could range between calming public concern over safety standards, promoting positive but non-case specific safety massages or allocating liability. Given the highly contextual nature of legal causation (Hart & Honoré, 1985), adapting elements of existing theory into the model was considered appropriate.

7.1.3 Objective III:

Assess the utility and legal credibility of a risk management tool that interprets the quality of safety culture and measures the potential liability of an organisation engaged in commercial aviation.

Benchmarking the attributes within d3SC could give an indication of what elements or attributes of safety culture significantly contribute to safety performance across commercial aviation. Within the confines of this study, d3SC was only trialled against one organisation, Airamp. Should future research trials extend to more than one organisation, or provide longitudinal data of one organisation, comparison could be made to the impact of corporate policy, regulatory changes and reaction to high profile accidents. Given the lack of progress observed by the Health and Safety Executive and the CPS in the UK in developing any investigative template to assess safety culture, it is predominantly the individual organisations within aviation that are left to assess their own safety culture vis-à-vis potential corporate liability. If we consider Honoré's comments on neo-liberal perspectives on risk ownership (Buxton, 2002), this gives a potential direction for the allocation of risk ownership for safety culture assessment. This perspective aligns closely with that of Perrow (1999) and the cognisant risk ownership promoted by Weick & Sutcliffe, (2001). This potential future application of d3SC also resonates with Reason's (1997) observation of safety managers forgetting to be afraid and the ideas developed by Fruhen *et al* (2013), to encourage a state of chronic unease in those responsible for safety management.

The CAA have repeatedly delayed any formal assessment of safety culture since the project began in 2014 and is now suspended pending further assessment. As for the CMCHA limited amount of case law has emerged since the act received Royal Assent. However, in their prosecution strategy the Crown Prosecution Service (CPS) have merged corporate and individual criminal liability rather than attempt to formally assess the impact of safety culture as a recognised causal factor. In *R v Lion Steel Equipment* [2012], the pattern of CPS activity of jointly charging directors with manslaughter and offering a plea-bargaining arrangement against the offending company has offset the requirement to deal with the complex causational issues raised by organisational culture. However, the case highlighted that the judicial focus on corporate conduct is spread across numerous sources of assessment including internal audits and insurance recommendations. As observed by Faure (2014), the majority of regulation is a managed solution rather than enforcement action. The outline enforcement regime described in the CAA 2012 and the RESA 2008 are hybrid measures which clarify regulatory sanction, bridging the gap between regulation and criminal sanction. Little guidance exists on requisite standards of safety culture for operators in most jurisdictions.

7.2 Colour Coded Attributes

d3SC produced a visual representation of safety culture which provided an intuitive description of the relationship between safety culture and potential corporate liability. The model was utilised to interpret the safety culture of Airamp and consider its potential to legal attribution under corporate criminal law in the form of the CMCHA. The output of the study illustrated that a simplified overarching assessment of an organisation's safety culture could not only describe a distorted reality, through the aggregation of various sub-cultures but provided little in the way of explanation as to how improvements might be managed. Discussed in the literature review was the established notion that safety culture can be considered from an interpretative or functional perspective which has been challenged through the design and visual display of d3SC. The use of colour coded attributes of safety culture not only provided an intuitive overall perspective of the strength of safety culture but could also describe how individual areas of risk responsibility interacted to affect the whole organisation.

7.3 Significant Bottlenecks

Since its emergence as a concept, debate has continued on how best to employ safety culture as a means of improving safety performance. Its increased prominence in commercial aviation risk management provides something of a paradox for regulators, operators and the legal system. All these groups have differing priorities and agendas. Whilst on the macro scale the theory of developing improved safety cultures for commercial aviation is both desirable and logical, the practicalities of constructing and developing these cultures is problematic. This study intended to establish whether a legal standard of safety culture could be identified and defined for commercial aviation. The literature review described the considerable debate as to whether safety culture could be defined or a defined threshold established for commercial aviation and other safety critical industries. A legal standard was considered to be either a defined regulatory standard or a standard of operation which was recognised in law as one which achieved a socially acceptable standard such as ALARP, (David & Wilkinson, 2009), or more realistically an acceptable level of safety ALOS, (Bell, Glade, & Danscheid, 2006).

According to Grote *et al* (2004) even when compared to other technical industries such as healthcare or petro-chemical, commercial aviation is a highly regulated industry. Paradoxically, in this highly regulated industry, little progress has been made to date in establishing a regulatory standard of safety culture for operators in commercial aviation. As discussed in the literature review this could be that safety culture is in fact an unsuitable subject of regulatory governance, (Kringen, 2013). If the interpretation of safety culture is left to the criminal justice system, then the defensive inhibition of safety reporting could result in a significant restriction on organisational and industry wide learning.

7.4 Further Research

The interpretations made in this study are tentative and require further study and alternative approaches. This study was largely based around the legal system of the United Kingdom. The principle of aggregation in allocating corporate liability could be assessed in other jurisdictions such as Australia but d3Sc could also be amended towards the causal principles of other liability regimes such as *respondeat superior* in the United States.

One of the issues raised in the study is the sensitivity of the research topic to safety-brand sensitive organisations in commercial aviation. This will probably be an issue that permanently affects this type of study but may be partially mitigated by further debate and discussion of the subject of corporate criminalisation and aviation safety. There have been previous studies on the emergence of criminalisation (Dekker, 2003, 2007, 2011; Thomas, 2003, 2007; Dunn *et al*, 2009; Michaelides-Mateou & Mateou, 2010; Trögeler, 2011) but these have largely focussed on issues concerning individual rather than corporate criminalisation. Given the strong influence of safety culture on individual safety behaviours and therefore organisational safety performance, there is potentially significant gain from understanding how these influences could be managed towards improvement.

This study could usefully be followed up by a larger scale study to overcome some of the issues raised with small data samples. Airamp is a relatively small company and the return of 43 Likert questionnaires provided a marginal amount of data with which any inferences could be made. Further larger studies of different organisations over a period of time could provide longitudinal data on the potential impact of managed interventions. Larger sampling data could also invite better statistical validation techniques and internal comparisons.

7.5 First Things Last

The extent to which legal standards of safety culture can be applied to commercial aviation is determined by the two constituent elements of the initial research question. The first element was determined early in the research programme by defining the requisite legal standard of safety culture as that which could provide a defence of due diligence. This approach was explored through an extensive literature review and an in-depth study of relevant case law which promoted this principle as a generic determinant of corporate liability. The second element of the question was to determine the extent that that principle could be applied to an organisation engaged in commercial aviation. This was achieved by accumulating legally recognised attributes of safety culture into a visual form (d3SC) that could be appropriately manipulated by metrics of values and attitudes to safety. These metrics then had to be intuitively understood by the organisation's personnel in order to provide meaning to the causal relationship between their operational

behaviours and potential organisational liability. The multifaceted nature of safety culture requires innovative regulatory methods; overly prescriptive regulatory definitions or over simplification of safety culture metrics could produce misleading or even counter-productive outcomes. This study would suggest that if safety culture is to be introduced as a legal standard, it should be an innovative form of performance-based regulation, it should contextual to the nature of the operation and most importantly promoted and articulated by the organisation itself.

REFERENCES & ACCIDENT REPORTS

Abrahamsen, E. B., Asche, F., & Milazzo, M. F. (2013), '*An evaluation of the effects on safety of using safety standards in major hazard industries*', Safety science, 59, 173-178.

Air France, (2011), '*Remise a Air France des Recommandations de la Mission D'Expertise Externe'*, Air France Corporate Website: http://corporate.airfrance.com/en/press/press-releases/article/item/remise-a-air-france-des-recommandations-de-la-mission-dexpertise-externe/back/61/: accessed 7th June 2017.

Air France, (2014), *'Accident of Rio-Paris flight - Referral to Criminal Court: Air France reaction'*, Air France Corporate Website: http://alphasite.airfrance.com/en/s01/press-releases#communique3729: accessed 12th August 2017.

Almond, P., & Colover, S. (2010), '*Mediating punitiveness: understanding public attitudes towards work-related fatality cases'*. European Journal of Criminology, *7*(5), 323-338.

Almond, P., (2013), '*Corporate Manslaughter and Regulatory Reform'*, Palgrave Macmillan, UK.

Amalberti, R. (2001), '*The paradoxes of almost totally safe transportation systems*', Safety science, 37(2), 109-126.

Antonsen, S. (2009), '*Safety culture and the issue of power*', Safety Science, 47(2), 183-191.

ATSB, (Australian Transport Safety Bureau), (2008), '*Analysis, Causality and Proof in Safety Investigations*': https://www.atsb.gov.au/media/27767/ar2007053.pdf: accessed 3rd September 2017.

Aven, T. (2013), '*On the meaning of a black swan in a risk context*'. Safety science, *57*, 44-51.

Ayres, I., & Braithwaite, J. (1995) '*Responsive regulation: Transcending the deregulation debate*', Oxford University Press on Demand.

Bandura, A. (1989) '*Human agency in social cognitive theory*', American Psychologist, 44(9), 1175.

Barnett, A. & Wang, A. (2000), *'Passenger-mortality Risk Provide Perspectives About Airline Safety*', (April) Flight Safety Digest (Flight Safety Foundation).

Barnett, A., (2010), '*Cross-National Differences in Aviation Safety Records',* Transportation Science, http://dx.doi.org/10.1287/trsc.1090.0313: accessed 21st August 2017.

Beck, U. (1992), '*Risk Society: Towards a New Modernity'*, Sage, London.

Bell, J. & Healey, N., (2006), '*The Causes of Major Hazard Incidents and How to Improve Risk Control and Health and Safety Management: A Review of the Existing Literature*.' Health and Safety Laboratory.

Bell, R., Glade, T., & Danscheid, M. (2006), '*Challenges in defining acceptable risk levels*', in RISK21—Coping With Risks due to Natural Hazards in the 21st Century, editors: Ammann, W. J., Dannenmann, S., & Vuliet, L., , 28, 77-87.

Bierly, P. E., & Spender, J. C. (1995), '*Culture and high reliability organizations: The case of the nuclear submarine*', Journal of Management, 21(4), 639-656.

Biggs S. E., Banks T. D., Davey J.D. & Freeman J. E., (2013), '*Safety leaders' perceptions of safety culture in a large Australian construction organisation*', Safety Science 52 (2013) 3-12.

Boeing (2016), '*Statistical Summary of Commercial Jet Airplane Accidents 1959-2015'*: http://www.boeing.com/resources/boeingdotcom/company/about_bca/pdf/statsum.pdf: accessed 12th June 2017.

Boer, J. D., & van Drunen, M. A. (2003) '*Occupational safety from a behavioural perspective*': https://research.vu.nl/en/publications/occupational-safety-from-a-behavioural-perspective: accessed 12th September 2017.

Böhm, A. (2004), '*Theoretical Coding: Text Analysis in Grounded Theory*', in Flick,

U., Kardoff, E. & Steinke, I., (Eds.), '*A Companion to Qualitative Research*', p. 270-275, London Sage.

Braithwaite, G. (2001), '*Attitude or Latitude? Australian Aviation Safety',* Ashgate.

Braun, V., Clarke, V., (2006), '*Using Thematic Analysis in Psychology*', Qualitative Research in Psychology, 3, 77–101. doi:10.1191/1478088706qp063oa

Brooks, B., (2008), "*The natural selection of organizational and safety culture within a small to medium sized enterprise (SME).*" Journal of safety research 39.1: 73-85.

Broyhill, C. M., (2016), '*The Effects of IS-BAO Implementation and Leadership Performance on Safety Culture in Business Aviation Flight Operations*', *Dissertations and Theses*. 200: http://commons.erau.edu/edt/200: accessed 12th September 2017.

Bryman, A., (2006), '*Integrating quantitative and qualitative research: How is it done?*', Qualitative Research, 6(1), 97-113.

Burke, W. W., & Litwin, G. H. (1992), '*A causal model of organizational performance and change*', Journal of management, 18(3), 523-545.

Buxton, R. (2002), Cane and Gardner (eds.): '*Essays for Tony Honore'*, Law Quarterly Review, 118, 476-478.

CAA [Civil Aviation Authority] Global Fatal Accident Review CAP 1036: 2002-2011: http://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=5605: accessed 12th September 2017.

Calabresi, G., (1970), '*The Cost of Accidents*', Yale University Press.

Calabresi, G & Bobbit, P., (1978), '*Tragic Choices: The Conflicts Society Confronts in the Allocation of Scarce Resources', Norton, New York.*

Cameron, K. S., & Quinn, R. E. (2011), '*Diagnosing and changing organizational culture: Based on the competing values framework*', John Wiley & Sons.

Canadian Government, (1994), '*Bill C-45 Overview'*: http://www.ccohs.ca/oshanswers/legisl/billc45.html: accessed 12th September 2017.

Cavanagh, N., (2011), '*Corporate Criminal Liability: An Assessment of the Models of*

Fault' Journal of Criminal Law/2011, Volume 75/Issue 5, October/Articles/ - JCL 75 (414).

CBI [Confederation of British Industry], (1990), '*Developing a safety culture – Business for safety'*, CBI, London.

Choudhry, R. M., Fang, D., & Mohamed, S. (2007). '*The nature of safety culture: A survey of the state-of-the-art*'. Safety science, 45(10), 993-1012.

Clarke, S., (2006), '*Contrasting perceptual, attitudinal and dispositional approaches to accident involvement in the workplace*'. Safety Science 44, 537–550.

Conklin, T. (2012) '*Pre-accident investigations: An introduction to organizational safety*', Ashgate Publishing, Ltd.

Cooper, M.D., (1997), '*Evidence from safety culture that risk perception is culturally determined*', The International Journal of Project & Business Risk *Management* 1.2 (1997): 185-202.

Cooper, M.D., (2000), '*Towards a model of safety culture'*, Safety Science 36, 111-136.

Cooper, C. R., & Denner, J. (1998), '*Theories linking culture and psychology: Universal and community-specific processes*', Annual review of psychology, 49(1), 559-584.

Cooper, M.D., Phillips, R.A., (2004), '*Exploratory analysis of the safety climate and safety behavior relationships*', Journal of Safety Research 35, 497–512.

Corbin, J. & Strauss, A., (2015), '*Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. 4th Ed.'*, Sage Publications Ltd.

Cox, L. A. T. (2012) '*Confronting deep uncertainties in risk analysis*', Risk Analysis, 32(10), 1607-1629.

Creswell, J. W., & Clark, V. L. P. (2007), '*Designing and conducting mixed methods research*', Sage Publishing.

Czech, B. A., Groff, L. & Strauch, B., (2014), *'Safety Cultures and Accident Investigation: Lessons Learned from a National Transportation Safety Board Forum':*

Safety Cultures and Accident Investigation: Lessons Learned from a National Transportation Safety Board Forum, Adelaide, Australia 13-16 October 2014.

Damaska, M. R., (1975), '*Structures of Authority and Comparative Criminal Procedure',* Faculty Scholarship Series. Paper 1590. http://digitalcommons.law.yale.edu/fss_papers/1590: accessed: 12th September 2017.

David, R. and Brierley, J. (1985), '*Major legal systems in the world today'*, 3rd ed Stevens & Sons London.

David, R. & Wilkinson, G. (2009), '*Back to Basics: Risk Matrices and ALARP*', in '*Safety Critical Systems: Problems, Process and Practice*', Springer, London: ISBN-978-1-84882-348-8.

Dekker, S., (2003). '*When human error becomes a crime'*, Human Factors and Aerospace Safety, 3(1), 83-92.

Dekker, S., (2005), '*Ten Questions About Human Error, A New View of Human Factors and System Safety*.' Taylor & Francis. London.

Dekker, S., (2007), '*Just Culture, Balancing Safety and Accountability*', Ashgate Publishing, Farnham, UK.

Dekker, S., (2011), '*The criminalization of human error in aviation and healthcare: A review*', Safety Science 49, 121–127, Elsevier.

Dekker, S. & Nyce, J.M., (2011), '*Cognitive Engineering and the Moral Theology and Witchcraft of Cause*', Cogn Tech Work, DOI 10.1007/s10111-011-0203-6.

Dekker, S., & Nyce, M, (2014), '*There is safety in power, or power in safety*,' Safety Science 67: 44-49.

Dekker, S., (2016), '*Drift into failure: From hunting broken components to understanding complex systems*', CRC Press.

Department of Justice (2013), '*BP Exploration and Production Inc. Pleads Guilty, Is Sentenced to Pay Record $4 Billion for Crimes Surrounding Deepwater Horizon*

Incident': http://www.justice.gov/opa/pr/2013/January/13-ag-123.html: accessed 12th September 2017.

Dempsey, S. P., (2010), '*Independence of Aviation Safety Investigation Authorities: Keeping the Foxes from the Henhouse'*, Journal of Air Law and Commerce, Vol. 75 (2).

Denison, D. R., & Mishra, A. K. (1995), '*Toward a theory of organizational culture and effectiveness*', Organization science, 6(2), 204-223.

Denison, D. R. (1996), '*What is the difference between organizational culture and organizational climate? A native's point of view on a decade of paradigm wars*', Academy of management review, 21(3), 619-654.

Devlin, P. (1979) *The Judge*, Oxford University Press, Oxford.

Donaldson, M. & Watters, R., [Allens-Arthur-Robinson], (2008), '*Corporate Culture as a Basis for the Criminal Liability of Corporations',:* http://198.170.85.29/Allens-Arthur-Robinson-Corporate-Culture-paper-for-Ruggie-Feb-2008.pdf: accessed 12th September 2017.

Ducasse, C.J., (1993), '*On the Nature and Observability of the Causal Relation'*, in '*Causation*', Sosa, E. & Tooley, M. (Editors), Oxford University Press.

Dunn, R.M., Colombo, S.M. & Nold, A.E., (2009), '*In Aviation, Are Prosecutorial Investigations Relegating Safety to the Back Seat?',* The Brief, Spring 2009: 11-21.

Dworkin, R., (1986), '*Law's Empire'*, Hart.

EASA, (European Aviation Safety Agency), (2016), '*EASA Annual Safety Review 2016*': https://www.easa.europa.eu/newsroom-and-events/news/easa-annual-safety-review-2016: accesed: 12th September 2017.

Edkins, G., & Coakes, S. (1998), '*Measuring safety culture in the Australian regional airline industry: The development of the airline safety culture index (ASCI)*'. Safety science, *26*(2).

Edwards, J. R., Davey, J., & Armstrong, K. (2013), '*Returning to the roots of culture: A review and re-conceptualisation of safety culture*', Safety Science, 55, 70-80.

Epstein, R. A. (1987), '*Causation-In Context: An Afterword*'., Chi.-Kent L. Rev., 63, 653.

Esler, D., (2009), '*Flight risk: The threat of criminalization*', Business and Commercial Aviation 104.3.

FAA/EUROCONTROL (2007).*'ATM Safety Techniques and Toolbox Safety Action Plan15'*: https://www.eurocontrol.int/eec/gallery/content/public/document/eec/report/2007/023_Safety_techniques_and_toolbox.pdf: accessed 12th September 2017.

Fang, D., & Wu, H. (2013), '*Development of a Safety Culture Interaction (SCI) model for construction projects*', Safety science, *57*, 138-149.

Faure, M.G., (2014), *'The complementary roles of liability, regulation and insurance in safety management: theory and practice',* Journal of Risk Research, Vol. 17, No. 6, 689–707.

Feinberg, J., (1984), '*Harm to Others, vol. 1 of The Moral Limits of the Criminal Law*', Oxford University Press.

Fenton, N., & Neil, M. (2012), '*Risk assessment and decision analysis with Bayesian networks*', CRC Press.

Fischel, D. R., (1982), '*The Corporate Governance Movement*', Vanderbilt Law Review*,* 35 1259.

Fisse, B. & Braithwaite, J. (1993), '*Corporations, Crime and Accountability*' (Cambridge University Press Cambridge) 48.

Fleming, M., (2001), '*Safety Culture Maturity Model',* HSE, HM Stationary Office.

Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000), '*Measuring safety climate: identifying the common features*', Safety science, 34(1), 177-192.

Flin, R. (2007), '*Measuring safety culture in healthcare: A case for accurate diagnosis*', Safety science, 45(6), 653-667.

Forlin, G. QC & Smail, L., (2014), '*Corporate Liability: Work Related Deaths and Criminal Prosecutions*, 3rd Edn.', Bloomsbury.

Foucault, M., (1979), '*Discipline and Punishment, trans. Alan Sheridan*.' New York: Vintage.

Fowler, D., & Pierce, R. (2012), '*A safety engineering perspective*', In Systems Engineering-Practice and Theory: https://link.springer.com/chapter/10.1007/978-1-4471-2494-8_10 : accessed 12th September 2017.

Francis, R., (QC), (2013), '*Report of the Mid-Staffordshire NHS Foundation Trust, Public Enquiry'*: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/279124/0947.pdf: accessed 12th September 2017.

Fraher, A. L. (2014), '*The Next Crash: How Short-Term Profit Seeking Trumps Airline Safety*', Cornell University Press.

Fruhen, L., Flin, R., & McLeod, R. (2013), '*Chronic unease for safety in managers: A Conceptualisation*', Journal of Risk Research, 17, 969–979. doi:10.1080/13669877.2013.822924

FSF, [Flight Safety Foundation] (2010), http://flightsafety.org/media-center/press-releases/2010-press-releases/accident-investigator-group-sign-criminalization-resolution: accessed 12th September 2017.

Gadd, S.A., & Collins, A. M., (2002), '*Safety Culture: a review of the literature*', HSE, HSL/2002/25.

Gadd S.A., Keeley D.M. and Balmforth H.F., (2004), '*Pitfalls in risk assessment: examples from the UK*', Safety Science, Vol. 42, pp. 841-857.

GAO, (United States General Accounting Office), (1997), '*Aviation Safety: Efforts to Implement Flight Operational Quality Assurance Programs*', GAO/RCED-98-10.

Gelman, A. (2008), '*Objections to Bayesian statistics*', Bayesian Analysis, 3(3), 445-449.

Giddens, A. (1999), '*Runaway World: How Globalisation is Reshaping our Lives*', St Edmundsbury Press.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013), '*Seeking qualitative rigor in inductive research: Notes on the Gioia methodology*', Organizational Research Methods, 16(1), 15-31.

Glaser, B. (2016), '*The Grounded Theory Perspective its Origins and Growth*', The Grounded Theory Review, Volume 15, Issue 1.

Glaser, B. & A. Strauss (1967), '*The discovery of grounded theory: strategies for qualitative research*', New York: de Gruyter, pp.185-220.

Glendon, A. I., & Stanton, N. A. (2000), '*Perspectives on safety culture*', Safety Science, 34(1), 193-214.

Glendon, I. (2008), '*Safety culture: snapshot of a developing concept*', Journal of Occupational Health and Safety–Australia New Zealand, 24(3), 179-189.

Gobert, J. & Mugnai, E., (2002), '*Coping with Corporate Criminality: Some Lessons from Italy'*, Crim LR 619 at 624.

Gobert M. & Punch M. (2003). '*Rethinking Corporate Crime',* Butterworths.

Green, L. (1962), '*Duties, Risks, Causation Doctrines*', *Tex. L. Rev.*, *41*, 42.

Grote, G. (2007), '*Understanding and assessing safety culture through the lens of organizational management of uncertainty'*, Safety Science 45, 637-652.

Grote, G., Helmreich, R. L., Sträter, O., Häusler, R., Zala-Mezö, E., & Sexton, J. B. (2004), '*Setting the stage: characteristics of organisations, teams and tasks influencing team processes*', Group interaction in high risk environments. Ashgate, Aldershot, UK, 111-140.

Grote, G. & Wiechbrodt, J., (2013), '*Why regulators should stay away from safety culture and stick to rules instead'*. In Bieder, C. & Bourrier, M. (Eds.), '*Trapping Safety*

into Rules: How Desirable and Avoidable is Proceduralization of Safety?' (Chapt. 11), Farnham: Ashgate.

Guldenmund, F. W. (2000), '*The nature of safety culture a review of theory and research'* Safety Science 34 (2000) 215-257.

Guldenmund, F. W. (2007), '*The use of questionnaires in safety culture research-an evaluation*', Safety Science, 45, 723–743. doi:10.1016/j.ssci.2007.04.006.

Gunningham, M. (1987) '*Negotiated Non-Compliance: A Case Study of Regulatory Failure*' 9 Law & Policy 69.

Gutteridge, H. C., (2015), '*Comparative law: an introduction to the comparative method of legal study and research*', (Vol. 1). CUP Archive.

Haack, S. (2004), '*Truth & Justice, Inquiry & Advocacy, Science & the Law'*, Ratio Juris, Vol. 17 No. 1.

Haddon-Cave, C. (2009), '*An independent review into the broader issues surrounding the loss of the RAF Nimrod MR2 Aircraft XV230 in Afghanistan in 2006*', The Stationary Office, London.

Hale, A.R. (2000), '*Culture's Confusions*', Safety Science, Vol. 34, 1-14.

Hale, A.R., Guldenmund, F.W., Van Loenhout, P.L.C.H., Oh, J.I.H., (2010), '*Evaluating Safety Management & Culture Interventions to Improve Safety: Effective Intervention Strategies*', Safety Science 48 1026-1035.

Hart, H.L.A. & Honore, A., (1985), '*Causation in the Law (2nd Edn)'.* Oxford University Press.
Hart, H.L.A., (2012), '*The Concept of Law, 3rd Edn'*, Oxford University Press, England.

Haukelid, K. (2008), '*Theories of (safety) culture revisited – an anthropological approach'*, Safety Science, 46, 413–426. doi:10.1016/j.ssci.2007.05.014.

Helmreich, R. L., & Merritt, A. C. (1998), '*Organizational culture: Culture at work in aviation and medicine*', 107-174.

Herber, E, (2014), '*A crime called nuclear power": The role of criminal law in*

addressing post-Fukushima damages', International Journal of Law, Crime and Justice, xx (2014) 1-22.

Hirsch, P.M. & Levin, D.Z., (1999), '*Umbrella advocates versus validity police: A life-cycle model*', Organizational Science; Linthicum Vol.10 Issue 2, (Mar/Apr).

Hofstede, G., (2001), '*Culture's Consequences: Comparing Values, Behaviours and Organizations Across Nations',* Sage Publishing.

Hofstede, G., & Minkov, M. (2010), '*Long-versus short-term orientation: new perspectives'*, Asia Pacific business review, 16(4), 493-504.

Hofstede, G, (2011), '*Dimensionalizing cultures: The Hofstede model in context'*, Online readings in psychology and culture 2.1 8.

Holton, J. A., & Walsh, I. (2016), '*Classic grounded theory: applications with qualitative and quantitative data*', SAGE Publications.

Hollnagel, E. (2004), '*Barriers and Accident Prevention'*, Ashgate, Aldershot, UK.

Hollnagel, E., (2014), '*Safety-1 and Safety-2, The Past & Future of Safety Management*', Ashgate, Farnham, Surrey.

Holland, J.A. & Webb, J.S. (1991) *Learning Legal Rules*, Blackstone, London.

Hopkins, A., (2002), '*Safety Culture, Mindfulness and Safe Behaviour: Converging Ideas?*', Working Paper 7: http://regnet.anu.edu.au/sites/default/files/publications/attachments/2015-05/WorkingPaper_7_0.pdfaccessed 12th September 2017.

Hopkins, A., (2005), '*Safety, Culture and Risk'*, CCH Australia Ltd.

Hopkins, A., (2006), '*Studying organisational cultures and their effects on safety*', Safety Science, Vol. 44, 10, 875-889: http://dx.doi.org/10.1016/j.ssci.2006.05.005: accessed 12th September 2017.

Hopkins, A. (2014a). '*Issues in Safety Science'*, Safety science, *67*, 6-14.

Hopkins, A., (2014b), '*Why 'Safety Cultures' Don't Work*', Decomworld: http://www.decomworld.com/offshore-safety/content4.php: accessed 12th July 2017.

Hopkins, A., (2015), '*The cost-benefit hurdle for safety case regulation'*, Safety Science, vol. 77, pp. 95-101: http://dx.doi.org/10.1016/j.ssci.2015.03.022: 12th September 2017.

Hopkins, A. & Maslen, S., (2015), '*Risky Rewards: How Company Bonuses Affect Safety'*, Ashgate Publishing.

HSE (Health & Safety Executive), (1988), '*The Tolerability of Risk from Nuclear Power Stations*', HMSO: http://www.legco.gov.hk/yr11-12/english/panels/se/papers/se0403cb2-1635-1-e.pdf: accessed 12th September 2017.

HSE (Health & Safety Executive), (2001), '*Reducing Risks and Protecting People'*, http://www.hse.gov.uk/risk/theory/r2p2.pdf: accesses 12th August 2017.

HSE (Health & Safety Executive), (2005a), '*Inspectors Toolkit: Human Factors in the Management of Major Accident Hazards'*: http://www.hse.gov.uk/humanfactors/topics/toolkit.pdf: accessed 12th September 2017.

HSE(Health & Safety Executive), (2005b), '*Development & Validation of the HMRI safety culture inspection toolkit'*: http://www.hse.gov.uk/research/rrpdf/rr365.pdf:accessed 12th August 2017.

HSE (Health & Safety Executive), (2007), '*BP Texas City Incident; Baker Review*': http://www.hse.gov.uk/chemicals/workshop/human-factors-09/texas-city-incident.pdf: accessed 12th September 2017.

HSE (Health & Safety Executive), (2017), '*Mesothelioma in Great Britain: annual deaths, IIDB cases and projected future deaths to 2030'*: http://www.hse.gov.uk/statistics/causdis/mesothelioma/: accessed 12th September 2017.

Hubbard, D. W. (2009), '*The failure of risk management: Why it's broken and how to fix it'*. John Wiley & Sons.

Hudson P. (2007), '*Implementing a safety culture in a major multi- national'*, Safety Science; 45:697–722.

Hudson, P., (2014), '*Accident causation models, management and the law'*. Journal of Risk Research, 17:6, 749-764, DOI: 10.1080/13669877.2014.889202

IATA (International Air Transport Association), (2017), '*Safety Report 2016: 53rd Edn.*': http://www.iata.org/publications/Pages/safety-report.aspx: accessed 12th September 2017.

ICAO (International Civil Aviation Organisation), (2013), Safety Management Manual (SMM) 3rd Edition, Doc 9859 AN/474.

ICAO (International Civil Aviation Organisation), (2013a), *'Annex 19 to the Convention on International Civil Aviation, Safety Management',* (1st edn. July 2013).

ICAO (International Civil Aviation Organisation), (2015), '*Manual of Aircraft Accident and Incident Investigation'*, 2nd Edition: Doc 9756 AN/965.

ICAO (International Civil Aviation Organisation), (2016), '*Safety Report: A Co-Ordinated Risk-Based Approach to Improving Global Aviation Safety'*: https://www.icao.int/safety/Documents/ICAO_Safety_Report_2015_Web.pdf: accessed 12th September 2017.

ICAO, (International Civil Aviation Organisation), (2016a), '*Annex 13 to the Convention on International Civil Aviation, Aircraft Accident and Incident Investigation'*, (11th edn. July 2016, incorporating amendments 1-15).

INPO (Institute of Nuclear Power Operations), (2011), '*Special Report on the Nuclear Accident at the Fukushima Daiichi Nuclear Power Station*', INPO 11-005, Atlanta , GA.

Irvine, A., Drew, P., & Sainsbury, R. (2013), '*Am I not answering your questions properly? Clarification, adequacy and responsiveness in semi-structured telephone and face-to-face interviews*', Qualitative Research, 13(1), 87-106.

Jensen, M.C. & Meckling, W.H., (1976), '*The Theory of the Firm, Managerial Behaviour, Agency Costs, and Ownership Structure*': http://www.sciencedirect.com/science/article/pii/0304405X7690026X: accessed 12th September 2017.

Johnson, C.W., (2008), '*Ten contentions of corporate manslaughter legislation: Public policy and the legal response to workplace accidents*', Safety Science, 46 (3), 346-370.

Johnson, C.W., Kirwan, B., Licu, A. & Stastny, P., (2009), '*Recognition primed decision making and the organisational response to accidents: Überlingen and the challenges of safety improvement in European air traffic management*', Safety Science, 47, 853-872.

Jolowicz J. (1996) `*The Woolf report and the adversary system',* 15 Civil Justice

Quarterly 198, 200.

Kahneman, D. (2011), '*Thinking, fast and slow'*. Macmillan.

Kasperson, R. E., Renn, O., Slovic, P., Brown, H. S., Emel, J., Goble, R., & Ratick, S. (1988), '*The social amplification of risk: A conceptual framework*', Risk analysis, 8(2), 177-187.

Kelley, P. J., (1978), '*Causation and Justice: A Comment*', Wash. ULQ, 635.

Kim, D.H. & Choi J.Y., (2016), '*Measuring Safety Culture to Promote Aviation Safety Culture*': http://kpubs.org/article/articleTagCloud.kpubs?articleANo=OGGHBK_2016_v35n2_111: accessed 12th August 2017.

Kirk, D. (2012), '*Criminalising Bad Bankers'*. The Journal of Criminal Law, 76(6), 439-441.

Klein, G. A. (1999), '*Sources of power: How people make decisions*', MIT press.

Kringen, J., (2013), '*Proceduralization & Regulation of Culture: Experiments on the Frontiers Risk Regulations,*. In Bieder, C. & Bourrier, M. (Eds.), '*Trapping Safety into Rules: How Desirable and Avoidable is Proceduralization of Safety*?' (Chapter 12). Farnham: Ashgate.

Krosnick, J.A. & Presser, S. (2010), '*Question and Questionnaire Design'* in: Handbook of Survey Research. 2nd Edn. Emerald. pp.263-313.

La Porte, T. & Consolini, P. (1991) '*Working in Practice but not in Theory: Theoretical Challenges of "High Reliability Organisations*"': https://www.jstor.org/stable/1181764 accessed 12th September 2017.

Lawson, R., [QC], (2015), '*Lawyers: the challenge of the perennial gatecrashers*'; address given at the 100 Year Anniversary of the UK AAIB: 100 Years of Accident Investigation, What Next?

Le Coze, J. C. (2013), '*What have we learned about learning from accidents? Post-disasters reflections*', Safety science, 51(1), 441-453.

Le Coze, J. C. & Wiig, S., (2013), '*Beyond Procedures: Can Safety Culture be Regulated?*', In '*Trapping Safety into Rules: How Desirable and Avoidable is Proceduralization of Safety*?' (Chapter 12). Farnham: Ashgate.

Leveson, N. (2004), '*A new accident model for engineering safer systems'*, Safety science, 42(4), 237-270.

Leveson, N., Dulac N., Marais K. & Carroll J. (2009), '*Moving Beyond Normal Accidents and High Reliability Organizations: A Systems Approach to Safety in Complex Systems'*, Organization Studies 2009 30: 227, Sage.

Leveson, N. G., (2011a), '*Engineering a Safer World: Systems Thinking Applied to Safety (Engineering Systems)',* The MIT Press, Cambridge, Mass.

Leveson, N. G. (2011b), '*Risk Management in the Oil and Gas Industry, Testament of Professor Nancy G Leveson before the US Senate Committee on Energy and Natural Resources'*, accessed 20.11.12 <http://mitei.mit.edu/news/risk-management-oil-and-gas-industry>: accessed 12th August 2017.

Leveson, N.G. (2011c), '*Engineering a safer world: Systems thinking applied to safety*', MIT press.

Levi, M. & Horlick-Jones, T., (2013), '*Interpreting the Fukushima Daiichi nuclear incident: some questions for corporate criminology'*, Crime Law Soc Change, 59:487-500 DOI 10.1007/s10611-013-9432-3

Li, Wen-Chin, Don Harris, and Aurora Chen, (2007), '*Eastern minds in western cockpits: meta-analysis of human factors in mishaps from three nations'*, Aviation, space, and environmental medicine 78.4 (2007): 420-425.

Li, W. C., Young, H. T., Wang, T., Harris, D., & Li, L. W. (2009), '*Approaches of Aviation Accident Investigation in Different Cultural Contexts from Human Factors Perspectives*', Journal of Aeronautics, Astronautics and Aviation. Series A, 41(1), 53-59.

Lofquist, E. A. (2010), '*The art of measuring nothing: The paradox of measuring safety in a changing civil aviation industry using traditional safety metrics*', Safety science, 48(10), 1520-1529.

Löfstedt, R., (2011), '*Reclaiming Health and Safety for All: An Independent Review of Health and Safety Regulation'*: HMSO: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66790/lofstedt-report.pdf: accessed 12th September 2017.

Luxhoj, J. T. (2003), '*Probabilistic causal analysis for system safety risk assessments in commercial air transport*': https://ntrs.nasa.gov/search.jsp?R=20030111706: accessed 12th September 2017.

Mackie, J.L., (1980), '*The Cement of the Universe*', Clarendon Press.

Maiti, J., Chatterjee, S., Bangdiwala, S.I., (2004)., '*Determinants of work injuries in mines:an application of structural equation modeling*', Injury Control and Prevention 11(1), 29-37.

Manuele, F. A. (2011), '*Reviewing Heinrich: Dislodging two myths from the practice of safety*', Professional Safety, 56(10), 52.

Marais, K., Dulac, N. & Leveson, N., (2004), '*Beyond Normal Accidents and High Reliability Organizations: The Need for an Alternative Approach to Safety in Complex Systems'*, Engineering Systems Division Symposium, MIT, Cambridge, MA.

Marples, D.R., (2014), '*Chernobyl: Crime without Punishment'*: 154-155.

Martin, J. (2001), '*Organizational culture: Mapping the terrain*', Sage Publications.

Michaelides-Mateou, S. and Mateou A. (2010), '*Flying in the Face of Criminalisation: The safety implications of prosecuting aviation professionals for accidents'*. Farnham, England: Ashgate Publishing.

Michalowski, R, (1985), '*Order, Law and Crime: An Introduction to Criminology'*, Random House, New York.

Mill, J. S. (1854), '*A System of Logic, Ratiocinative and Inductive, being a Connected View of the Principles of Evidence, and the Methods of Scientific Investigation*', Third Edition. 2 vols. 8vo.

Ministry of Justice (2008), '*A Guide to the Corporate Manslaughter Corporate Homicide Act 2007'*: http://www.gkstill.com/Support/Links/Documents/2007-justice.pdf: accessed 12th September 2017.

Mintzberg, H. (1995), '*Musings on management. Ten ideas designed to rile everyone who cares about management*', Harvard business review, 74(4), 61-67.

Mishina, Y., Dykes, B. J., Block, E. S., & Pollock, T. G. (2010). '*Why "good" firms do bad things: The effects of high aspirations, high expectations, and prominence on the incidence of corporate illegality*', *Academy of Management Journal*, *53*(4), 701-722.

Montijn, C., & de Jong, H. (2007), '*A synthesis of the literature on safety culture: definitions, characteristics, indicators and classification scheme*', In *Proceedings of the Eurocontrol, Annual Safety R&D seminar",* Rome (pp. 24-26).

Morley, J. & Harris, (2006), '*Ripples in a Pond: An Open System Model of the Evolution of Safety Culture*', International Journal of Occupational Safety & Ergonomics, 12-1, 3-15.

Morley, J. & Stuart J., (2014), '*Improving Investigation of Organizational & Management Factors*'; Forum, Journal of ISASI, April-June 2014: http://www.isasi.org/Documents/ForumMagazines/Forum_Spring_2014_Web.pdf: accessed 12th August 2017.

Nævestad, T. O. (2009), '*Mapping research on culture and safety in High-Risk organizations: Arguments for a sociotechnical understanding of safety culture*', Journal of Contingencies and Crisis Management, 17(2), 126-136.

Nascimento, F., Majumdar, A., & Ochieng, W. (2013). Investigating the truth of Heinrich's pyramid in offshore helicopter transportation. *Transportation Research Record: Journal of the Transportation Research Board*, (2336), 105-116.

National Commission on the BP Deepwater Horizon Oil Spill (2011), https://www.gpo.gov/fdsys/pkg/GPO-OILCOMMISSION/pdf/GPO-OILCOMMISSION.pdf: accessed 12th September 2017.

Neal, A., & Griffin, M. A. (2002), '*Safety climate and safety behaviour*', Australian journal of management, 27(1_suppl), 67-75.

Neilson, K.J., (2013), '*Improving Safety Culture through a Health and Safety Organization: A case Study*', Journal of Safety Research, 48 (2014) 7-17.

Nemsick, J. & Passeri, S.G., (2012), '*Criminalizing Aviation: Placing Blame Before* Safety', American Bar Association Journal: http://apps.americanbar.org/litigation/committees/masstorts/articles/winter2012-criminalizing-aviation-blame-safety.html: accessed 12th September 2017.

Netjasov, F., & Janic, M. (2008). A review of research on risk and safety modelling in civil aviation. *Journal of Air Transport Management*, *14*(4), 213-220.

Nietzsche, F., (1889), '*Götzen-Dämmerung, oder, Wie man mit dem Hammer philosophirt*': http://www.lexido.com/EBOOK_TEXTS/TWILIGHT_OF_THE_IDOLS_.aspx?S=7; accessed 12th September 2017.

Noort, M.C., Reader, T.W., Shorrock, S. & Kirwan, B., (2016), '*The relationship between national culture and safety culture: Implications for international safety culture assessments'*, Journal of Occupational and Organizational Psychology (2016), 89, 515–538: DOI:10.1111/joop.12139.

Orasanu, J., & Connolly, T. (1993), '*The reinvention of decision making*', In *'Decision Making in Action: Models and Methods*', American Psychological Association, New York Press.

Parker, D., Lawrie, M., & Hudson, P. (2006), '*A framework for understanding the development of organisational safety culture*', Safety science, 44(6), 551-562.

Paté-Cornell, E. (2012), '*On "Black Swans" and "Perfect Storms": risk analysis and management when statistics are not enough*', Risk analysis, 32(11), 1823-1833.

Pearson, M.W. & Riley, D.S., (2015), '*Foundations of Aviation Law*', Farnham, England: Ashgate Publishing.

Perrow, C. (1999), '*Normal accidents: Living with high risk technologies*'. Princeton University Press, 2011.

Pidgeon, N. (1998) '*Safety culture: key theoretical issues*', Work & Stress, 12(3), 202-216.

Pidgeon, N. F., Lorenzoni, I & Poortinga, W., (2008), '*Climate change or nuclear power—No thanks! A quantitative study of public perceptions and risk framing in Britain.*' Global Environmental Change 18.1 69-85.

Piers, M., Montagne, C. & Balk, A., (2009), '*Safety Culture Framework for the ECAST SMS WG'*: http://www.atcvantage.com/docs/culture_NLR_SafetyCultureFramework_WP1-ECASTSMSWG-1.pdf: accessed 12th September 2017.

Pinto, A & Evans M, (2008), '*Corporate Criminal Liabilty*' (2nd Edn.) Thomson, London, England.

Rabinow, P., (1984), '*The Foucault Reader*', Random House, New York.

Rasmussen, J., (1997), '*Risk Management in a Dynamic Society: A Modelling Problem'*, Safety Science, Vol. 27, Issues 2-3, 183-213.

Reader, T. W. & O'Connor, P. (2014) '*The Deepwater Horizon explosion: Non-technical skills, safety culture, and system complexity*'. Journal of Risk Research, 17, 405–424: DOI:10.1080/13669877.2013.815652

Reader, T.W., Noort, M.C., Shorrock, S. & Kirwan, B., (2015), '*Safety sans Frontieres: An International Safety Culture Model*': Risk Analysis, Vol. 35, No. 5, 2015.DOI: 10.1111/risa.12327.

Reason, J.T., (1990) '*Human error*', Cambridge University Press.

Reason, J.T., (1997), '*Managing the risks of organizational accidents*'. Vol. 6. Aldershot: Ashgate.

Reason, J. (2000), '*Safety paradoxes and safety culture'*, Injury Control and Safety Promotion, 7(1), 3-14.

Richards, T., (1996), '*The Westray Mine Explosion: An Examination of the Interaction Between the Mine Owner and the Media*', Canadian Journal of Communication, [S.l.], v. 21, n. 3, March: http://www.cjc-online.ca/index.php/journal/article/view/954/860>:accessed: 12th August 2017.

Ritchie, J., Lewis, J., Nicholls, C. M., & Ormston, R. (Eds.), (2013), '*Qualitative research practice: A guide for social science students and researchers*', Sage.

Roberts, K. H., & Rousseau, D. M. (1989) '*Research in nearly failure-free, high-reliability organizations: having the bubble*', IEEE Transactions on Engineering management, 36(2), 132-139.

Roberts, K. H., Bea, R., & Bartles, D. L. (2001), '*Must accidents happen? Lessons from high-reliability organizations*', The Academy of Management Executive, 15(3), 70-78.

Rodrigues, C. C., & Cusick, S. K. (2012), *'Commercial aviation safety'*, Columbus, OH: McGraw-Hill.

Rosenmerkel, S. P. (2001). '*Wrongfulness and harmfulness as components of seriousness of white-collar offenses'*. Journal of Contemporary Criminal Justice, 17(4), 308-327.

Royal Society Study Group, (1992), '*Risk: Analysis, perception and management'*, HMSO.

Ruijters, E., & Stoelinga, M. (2015), '*Fault tree analysis: A survey of the state-of-the-art in modeling, analysis and tools*', Computer science review, *15*, 29-62.

Salas, E., Burke, C.S., Bowers, C.A. & Wilson, K.A., (2001), '*Team training in the skies: does crew resource management (CRM) training work*?' Human Factors 43, 641– 674.

Salmon, W.C., (1993), '*Probabilistic Causality'*, in '*Causation*', Sosa, E. & Tooley, M. (Editors), Oxford University Press.

Sarre, R., (2010), '*Sentencing those convicted of Industrial Manslaughter'*, National

Judicial Conference of Australia, Sentencing Conference, Canberra, 2010.

Saunders, F. C., Gale, A. W., & Sherry, A. H. (2015), '*Conceptualising uncertainty in safety-critical projects: A practitioner perspective*', International Journal of Project Management, 33(2), 467-478.

Savage, I. (2013), '*Comparing the fatality risks in United States transportation across modes and over time*', Research in Transportation Economics, 43(1), 9-22.

Schein, E.H., (1996), '*Three cultures of management: the key to organizational learning*'. Sloan Management Review 1996 (Fall) 9–20.

Schein, E. H., (2017), '*Organizational culture and leadership',* 5th Edition. John Wiley & Sons.

Schulman, P., (2013), '*Procedural Paradoxes and the Management of Safety*', In Bieder, C. & Bourrier, M. (Eds.), '*Trapping Safety into Rules: How Desirable and Avoidable is Proceduralization of Safety*?' (Chapter 12). Farnham: Ashgate.

Senge, P.M., (2006), '*The Fifth Discipline: The Art & Practice of The Learning Organisation*', Random House Business Books.

Shappell, S.A. and D.A. Wiegmann, (2001), "*Applying Reason: The Human Factors Analysis and Classification System (HFACS)*", Human Factors and Aerospace Safety, 1 (1), pp. 59-86.

Shrivastava, S, Sonpar, K, and Pazzaglia, F (2009), '*Normal Accident Theory versus High Reliability Theory: A resolution and call for an open systems view of accidents*', Human Relations; 62(9), 1357-1390.

Shrock, P. (2013), '*Political Interests and Regulatory Enforcement in the Aftermath of Accidents*'. Sociological Spectrum, 33(4), 295-312.

Simpson, S.S., Rorie, M., Alper, M., Schell-Busey, N., (2014), '*Corporate Crime Deterrence: A Systematic Review*', Campbell Systematic Reviews: 4.

Slapper, Gary (1993), '*Corporate manslaughter: An examination of the determinants of prosecutorial policy*', Social and Legal Studies, 2(4), pp. 423–443.

Slapper, G., (2010), '*Corporate Punishment*', Journal of Criminal Law, 74(3), pp. 181–184.

Slovic, P. & Weber, E.U., (2002), '*Perception of Risk Posed by Extreme Events'* In: Regulation of Toxic Substances and Hazardous Waste (2nd edition) (Applegate, Gabba, Laitos, and Sachs, Editors), Foundation Press, Forthcoming. Available at SSRN: https://ssrn.com/abstract=2293086: accessed 12th September 2017.

Snook, S. A., (1996) '*Practical drift: the friendly fire shootdown over northern Iraq*', (Doctoral dissertation, Harvard University).

Soeters, Joseph L., and Peter C. Boer, (2000), "*Culture and flight safety in military aviation*" The International Journal of Aviation Psychology 10.2 (2000): 111-133.

Steel, J., (2004), '*Risk and Legal Theory',* Hart Publishing, Oxford, England.

Stolzer, A. J., Halford, C. D., & Goglia, J. J. (Eds.). (2011), '*Implementing safety management systems in aviation'*, Ashgate Publishing, Ltd.

Stoop, J. A., & Kahan, J. P. (2017), '*Flying is the safest way to travel: How aviation was a pioneer in independent accident investigation'*, European journal of transport and infrastructure research EJTIR, 5 (2).

Strauch, B., (2015), '*Can we examine safety culture in accident investigations, or should we?*' Safety Science, 77: 102-111.

Strauss, A. & Corbin, J., (1998), '*Basics of qualitative research techniques*', Sage publications.

Talib, N. N., (2010), '*The Black Swan, The Impact of the Highly Improbable',* Penguin

Thomas, G. (2002), '*Aviation on Trial'*, Air Transport World, Vol. 39:9, Penton Media.

Thomas, G., (2007), Air Transport World. Jan 2007, Vol. 44 Issue 1, p57-59

Townsend, A. S., (2013), '*Safety Can't Be Measured: An Evidence Based Approach to Improving Risk Reduction'*. Gower Publishing Ltd., Farnham, UK.

Trögeler, M., (2011), '*Criminalisation of Air Accidents and the Creation of a Just Culture*': http://eala.aero/wp-content/uploads/2014/05/Mildred-Trîgeler-EALA-prize.pdf: accessed 12th September 2017.

Tucker, E. (1995), '*The Westray Mining Disaster and its Aftermath: the Politics of Causation*', Canadian Journal of Law Studies, IH, 1 91.123.

US [United States] Attorney's Office, District of New Jersey (2011), '*Founders of Luxury Charter Jet Company Sentenced to Prison in Illegal Flight Scheme*': https://www.justice.gov/archive/usao/nj/Press/files/Brassington,%20Michael%20and%20Paul%20Sentencing%20News%20Release.html: accessed 12th September 2017.

US [United States] v. SabreTech, Inc., 271 F.3d 1018, 1021 (11th Cir. 2001): http://www.leagle.com/decision/20011289271F3d1018_11191.xml/U.S.%20v.%20SABRETECH,%20INC: accessed 12th September 2017.

Vasterman, P.C., (2005), '*Media-hype self-reinforcing news waves, journalistic standards and the construction of social problems',* European Journal of Communication 20.4 (2005): 508-530.

Vasterman, P. C., J. Yzermans and A.J.E., Dirkzwager, (2005), '*The role of the media and media hypes in the aftermath of disasters*', Epidemiologic reviews 27.1: 107-114.

Vaughan, D., (1997), '*The Challenger launch decision: Risky technology, culture, and deviance at NASA*', University of Chicago Press.

von Hirsch, A. (2014), '*Harm and Wrongdoing in Criminalisation Theory*', Criminal Law and Philosophy, 8(1), 245-256.

von Thaden, T. L. & Gibbons, A. M. (2008), '*The Safety Culture Indicator Scale Measurement System*' Human Factors Division, Institute of Aviation: Technical Report HFD-08-03/FAA-08-2.

Wahlstrom, B. & Rollenhagen, C. (2009), '*Assessment of Safety Culture: to measure or not?*' Paper presented at the 14th European Congress of Work and Organisational Psychology, 13th-16th May 2009, Santiago de la Compostella, Spain.

Wei, Jiuchang, Fei Wang, and Michael K. Lindell, (2016), '*The evolution of stakeholders' perceptions of disaster: A model of information flow'*, Journal of the Association for Information Science and Technology 67.2: 441-453.

Weick, K. E., Sutcliffe, K. & Obstfeld, D., (1999), '*Organising for high reliability*'. Research in Organisational Behaviour, 21,81-123.

Weick, K. E., and K. M. Sutcliffe, (2001), '*Managing the Unexpected: Assuring High Performance in an Age of Complexity*', San Francisco, CA: Jossey-Bass.

Weick, K. E. (2012), '*Making sense of the organization, Volume 2: The impermanent organization*' (Vol. 2). John Wiley & Sons.

Wiegmann, D. A., von Thaden, T. L., & Gibbons, A. M. (2007), '*A review of safety culture theory and its potential application to traffic safety*', Improving Traffic Safety Culture in the United States, 113.

Weissman, A., & Newman, D., (2007), '*Rethinking corporate criminal liability*.' Indiana Law Journal 82 (2007): 411.

Wells, C., (1996), '*Criminal Law, Blame and Risk: Corporate Manslaughter*': in Hood, C. & Jones C.K. (eds), (2003), '*Accident and Design: contemporary debates in risk management'*, Routledge, London.

Wells, C. (2001), 'Corporations and criminal responsibility'. Oxford University Press, England.

Wells, C. (2010), '*Corporate Criminal Liability: Exploring Some Models*', in The Law Commsion Paper 195: 'Criminal Liability in Regulatory Contexts': http://research-information.bristol.ac.uk/en/publications/corporate-criminal-liabilityexploring-some-models-in-consultation-paper-no-195(3ed744e8-cebd-4834-aa5c-955389957cd7)/export.html: accessed 7th September 2017.

Westrum, R. (1996), '*Human factors experts beginning to focus on organizational factors in safety'*, ICAO journal, 51(8), 6-8.

Wiegmann, D. A., von Thaden, T. L., & Gibbons, A. M. (2007), '*A review of safety culture theory and its potential application to traffic safety*': Improving Traffic Safety Culture in the United States, 113.

Woodley, M., (2013), '*Bargaining Over Corporate Manslaughter - What Price a Life?*'. Journal of Criminal Law, Vol. 77, Issue 1, JCL 77 (33).

Woods, D. D. & Cook, R. I., (2002), '*Nine Steps to Move Forward from Error'*, Cognition, Technology & Work, 4:137-144.

Woods, D. D., Dekker, S., Cook, R., Johannesen, L. & Sarter, N., (2010), '*Behind Human Error*', 2nd Edn., Ashgate, Farnham.

Wright, R. W. (1988): '*Causation, Responsibility, Risk, Probability, Naked Statistics, and Proof: Pruning the Bramble Bush by Clarifying the Concepts'*, 73 Iowa L. Rev. 1001: http://scholarship.kentlaw.iit.edu/fac_schol/698: accessed 12th September 2017.

Zhang, X., Bartol, K.M., Smith, K.G., Pfarrer, M.D., & Khanin, D.M., (2008), '*CEOs on the Edge: Earnings Manipulation & Stock-Based Incentive Misalignment*'. Academy of Management Journal, 51:241-258.

Zhang, H., Wiegmann, D. A., Von Thaden, T. L., Sharma, G., & Mitchell, A. A. (2002), '*Safety culture: A concept in chaos*?', In '*Proceedings of the Human Factors and Ergonomics Society Annual Meeting*' (Vol. 46, No. 15, pp. 1404-1408). Sage CA: Los Angeles, CA: SAGE Publications.

Zohar, D. (1980), '*Safety climate in industrial organizations: theoretical and applied implications*', Journal of applied psychology, 65(1), 96.

Zohar, D., (2010), '*Thirty years of safety climate research: Reflections and future directions'*, Accident Analysis and Prevention 42 (2010) 1517-1522.

ACCIDENT REPORTS

AAIASB, [Air Accident Investigation & Aviation Safety Board], (2006), '*Aircraft Accident Report, Helios Airways Flight HCY522, Boeing 737-31S, at Grammatiko, Hellas on 14th August 2005*.': http://www.aaiu.ie/sites/default/files/Hellenic%20Republic%20Accident%20Helios%20Airways%20B737-31S%20HCY522%20Grammatiko%20Hellas%202005-085-14.pdf: accessed 12th September 2017.

AAIB, (2017), '*Report on the Accident to Hawker Hunter T7 G-BXFI, Near Shoreham Airport on 22nd August 2015*': https://www.gov.uk/aaib-reports/aircraft-accident-report-aar-1-2017-g-bxfi-22-august-2015: accessed 12th September 2017.

AIIB, [Air Accident Investigation Board] (2002), '*Final Report of the Aircraft Accident Investigation Bureau on the accident to the Saab 340B aircraft, registration HB-AKK of Crossair flight CRX 498 on 10 January 2000 near Nassenwil/ZH*': https://web.archive.org/web/20080414072245/http://www.bfu.admin.ch/common/pdf/1781_e.pdf: accessed 12th September 2017.

ANSV, [Agenzia Nationale Per La Sicurrezza Del Volo], (2004): '*Accident involved aircraft Boeing MD-87, registration SE-DMA & Cessna 525-A, registration D-IEVX, Milano Linate airport, October 8, 2001*': http://www.comitato8ottobre.com/download/processo/it/79RELAZIONE%20DINCHIESTA%20LINATE.pdf: accessed 12th September 2017.

BEA, [Bureau d'Enquêtes et d'Analyses Pour la sécurité de l'aviation civile], (1993), '*Rapport de la commission d'enquête sur l'accident survenu le 20 janvier 1992 près du Mont Sainte-Odile (Bas Rhin) à l'Airbus A 320 immatriculé F-GGED exploité par la compagnie Air Inter*': http://www.bea.aero/docspa/1992/f-ed920120/htm/f-ed920120.html: Accessed 12th September 2017.

BEA, [Bureau d'Enquêtes et d'Analyses Pour la sécurité de l'aviation civile], (2002),'*Accident on 25 July 2000 at La Patte d'Oie in Gonesse (95) to the Concorde registered F-BTSC operated by Air France'*: https://www.bea.aero/uploads/tx_elydbrapports/f-sc000725a.pdf: accessed 12th September 2017.

BEA, [Bureau d'Enquêtes et d'Analyses Pour la sécurité de l'aviation civile], (2012),'*On the accident on 1st June 2009 to the Airbus A330-203 registered F-GZCP operated by Air France flight AF 447 Rio de Janeiro – Paris*': https://www.bea.aero/en/investigation-reports/notified-events/detail/event/accident-of-an-airbus-a330-203-registered-f-gzcp-and-operated-by-air-france-crashed-into-the-atlantic-ocean/: accessed 12th September 2017.

BFU [Bundesstelle für Flugunfalluntersuchung], (2004), '*Investigation Report: (AX001-1-2/02). Accident, 1 July 2002, (near) Uberlingen/Lake of Constance/ Germany.Type of Aircraft: Transport Aircraft: Boeing 757-200, Tupolev TU154M.*': https://www.bfu-web.de/EN/Publications/Investigation%20Report/2002/Report_02_AX001-1-2_Ueberlingen_Report.pdf?__blob=publicationFile: accessed 12th September 2017.

CAIB, [Columbia Accident Investigation Board], Volume One, NASA 2003: https://www.nasa.gov/columbia/home/CAIB_Vol1.html: accessed 12th September 2017.

CENIPA, [Centro de Investgacåo e Prevencåo de Acidentes Aeronåuticos], (2008) '*Final Report A-OOX/CENIPA/2008, Occurrence: Aeronautical Accident, Aircraft Registration: PR-GTD & N600XL, 29th September 2006*': http://www.skybrary.aero/bookshelf/books/546.pdf: accessed 12th September 2017.

CENIPA, [Centro de Investgacåo e Prevencåo de Acidentes Aeronåuticos], (2009), '*Final Report A – No. 67/CENIPA/2009 Occurrence: Aeronautical Accident, Aircraft: PR-MBK, Model: Airbus A-320, 17th July 2007*': http://www2.fab.mil.br/cenipa/index.php/formularios: accessed 12th September 2017.

CIAIAC (2010), '*Report A-032/2008 Accident involving a McDonnell Douglas DC-9-82 (MD-82) aircraft, registration EC-HFP, operated by Spanair, at Madrid-Barajas Airport, on 20 August 2008*': http://www.skybrary.aero/bookshelf/books/1717.pdf: accessed 12th September 2017.

Cullen, The Hon. Lord W. Douglas (1990), '*The public inquiry into the Piper Alpha disaster*'. London: H.M. Stationery Office. ISBN 0101113102.

Cullen, The Rt. Hon Lord Cullen PC (2001), '*The Ladbroke Grove Rail Inquiry*': http://www.railwaysarchive.co.uk/docsummary.php?docID=38: accessed 12th September 2017.

Department of Transport (1987), '*MV Herald of Free Enterprise: Report of Court No. 8074 Formal Investigation*': http://www.maib.gov.uk/cms_resources.cfm?file=/hoffefinal.pdf: accessed 12th September 2017.

Department of Transport (1988), '*Investigation into the King's Cross Underground Fire*': http://www.railwaysarchive.co.uk/documents/DoT_KX1987.pdf: accessed 12th September 2017.

Haddon-Cave, C. (2009), '*An independent review into the broader issues surrounding the loss of the RAF Nimrod MR2 Aircraft XV230 in Afghanistan in 2006*', The Stationary Office, London.

Hidden, A. (1989), '*Investigation into the Clapham Junction Railway Accident*': http://www.railwaysarchive.co.uk/docsummary.php?docID=36: accessed 12th September 2017.

IAEA [International Atomic Energy Authority] (1992), Safety Series INSAG-7: http://www-pub.iaea.org/books/IAEABooks/3786/The-Chernobyl-Accident-Updating-of-INSAG-1: accessed 12th September

2017.

Kurokawa, K., '*The National Diet of Japan, Fukushima Nuclear Accident Independent Investigation Commission*': https://www.nirs.org/wp-content/uploads/fukushima/SaishyuRecommendation.pdf: accessed 12th September 2017.

NASA, [National Aeronautical & Space Administration], (1986), '*The Report to the President by the Presidential Commission the Space Shuttle Challenger Accident*': http://history.nasa.gov/rogersrep/genindex.htm: accessed 12th September 2017.

National Commission, (2011), '*Deepwater: The Gulf Oil Disaster and the Future of Offshore Drilling*': https://www.gpo.gov/fdsys/pkg/GPO-OILCOMMISSION/pdf/GPO-OILCOMMISSION.pdf: Accessed 12th September 2017.

NTSB (1992), AAR-92/04, '*Britt Airways Inc. d/b/a Continental Express Flight 2574 In-Flight Structural Break-up Emb-120RT N7730 1 Eagle Lake Texas September 11th 1991*': http://www.ntsb.gov/investigations/AccidentReports/Reports/AAR9204.pdf: accessed 12th September 2017.

NTSB, [National Transport Safety Board], (1997), '*Aircraft Accident Report NTSB/AAR-97/06(PB97-910406), In Flight Fire and impact with Terrain, ValuJet Airlines Flight 592, DC-9-32, N904VJ Everglades, near Miami, Florida, May 11, 1996*': http://www.ntsb.gov/investigations/AccidentReports/Reports/AAR9706.pdf: accessed 12th September 2017.

NTSB, [National Transport Safety Board], (2002), '*Loss of Control and Impact with Pacific Ocean Alaska Airlines Flight 261, MacDonnell Douglas MD-83, N963AS About 2.7 Miles North of Anacapa Island, California, January 31, 2000*': http://www.ntsb.gov/investigations/AccidentReports/Reports/AAR0201.pdf: accessed 12th September 2017.

NTSB, [National Transport Safety Board], (2006), '*Accident Report on Runway Overrun and Collision Platinum Jet Management, LLC Bombardier Challenger CL-600-1A11, N370V, Teterboro, New Jersey, Feb. 5, 2005*': http://www.ntsb.gov/investigations/AccidentReports/Reports/AAR0604.pdf: accessed 12th September 2017.

ORR [Office of Rail Regulation], (2006), '*A Final Report by the Independent Investigation Board*': http://www.railwaysarchive.co.uk/docsummary.php?docID=465: accessed 12th September 2017.

Richard, K. P., (1997), '*The Westray Story: A Predictable Path to Disaster: Report of the Westray Mine Public Inquiry*': http://novascotia.ca/lae/pubs/westray/: accessed: 12th September 2017.

APPENDICES

Appendix A Questionnaire & Assigned Values of d3SC

BIOGRAPHICAL QUESTIONS	
QUESTION:	**OPTIONS:**
What type of organisation do you work for? :	Airline Air Taxi Helicopter Operations Air Freight Maintenance-Repair-Operations (MRO) Military Training Other (Please specify)
Approximately how many employees work for your organisation?	0 - 1000 1000 - 5000 5000 - 10,000 10,000 - 20,000 20,000 - 50,000 50,000+
A Senior Manager has been described as an individual who has a significant influence on organisational policy and operational standards. Would you describe your role within your organisation as:	Senior Manager Manager Operational (Non-Managerial) Administration or Support (Non-Managerial) Other

MAX VALUES OF EACH ATTRIBUTE GROUP:								
WBL	LRP	EAC	CAP	ALS	ISC	MXR	SBR	XRD
180	185	110	115	130	85	85	95	115

Q No.	**Q. Code**	**SAFETY +/-**	**1 DISAG**	**2**	**3**	**4**	**5 AGREE**	**MAX**
1	EAC5	- A	30	20	10	0	0	30
1. Employees do not believe that senior management hold safety as a high priority.								
2	ISC1	+ B	0	0	10	15	20	20
2. The company constantly looks for ways in which it can improve its safety culture.								
3	MXR1	+ C	0	0	5	10	15	15
3. Management do not tolerate risk management practices which compromise safety standards, whatever the financial benefits to the company may be.								
4	WBL6	+ C	0	0	5	10	15	15
4. Company staff engaged in safety management are given authority to act when safety concerns are raised.								
5	LRP7	- A	30	20	10	0	0	30
5 There are company practices that expose people to a level of risk that the general public would find unacceptable.								
6	CAP4	+ B	0	0	10	15	20	20
6. Management at all levels does not accept unsafe behaviour.								

7	ALS2	-	C	15	10	5	0	0	15
7. Company safety equipment is not maintained to the standards required by the regulator or the equipment instructions.								
8	SBR1	+	A	0	0	10	20	30	30
8. Company employees do not bend or break rules in order to benefit the company.								
9	XRD3	+	C	0	0	5	10	15	15
9. Operational staff are offered incentives for highlighting poor safety practices.								
10	MXR3	-	B	20	15	10	0	0	20
10. The company provides incentives to managers who implement cost saving policies or practices even though they may compromise safety standards.								
11	ALS6	+	B	0	0	10	15	20	20
11. None of the company's practices falls below an acceptable level of minimum legal compliance.								
12	WBL3	+	B	0	0	10	15	20	20
12. Senior management make a lot of effort to evaluate whether a corrective safety actions have been effective.								
13	WBL9	-	A	30	20	10	0	0	30
13. Senior managers do not want to know about significant safety concerns of employees.								
14	LRP2	-	B	20	15	10	0	0	20
14. Senior management invariably refuses any application for further budget to implement safety improvements.								
15	CAP1	-	C	15	10	5	0	0	15
15. Following an incident, departments start safety investigations with the assumption that someone is to blame.								

16	ISC3	+ C	0	0	5	10	15	15
16. Striving for an excellent safety culture is a high priority for this company.								
17	WBL2	+ B	0	0	10	15	20	20
17. Senior management take time to listen to the opinion of operational staff on safety threats.								
18	LRP4	- C	15	10	5	0	0	15
18. Safe behaviours or safety promoting behaviour is not rewarded.								
19	EAC2	- B	20	15	10	0	0	20
19. Unsafe behaviour is punished, arbitrarily; different managers apply different standards								
20	CAP2	- A	30	20	10	0	0	30
20. Departmental managers are aware of frequent deviations from correct procedure but do nothing about it.								
21	XRD2	- A	30	20	10	0	0	30
21. Management encourage operational practices that compromise safety standards.								
22	WBL5	- A	30	20	10	0	0	30
22. Following an accident or incident, the company looks for individuals to blame rather than any faults in the system.								
23	LRP8	- C	15	10	5	0	0	15
23. An accident or incident within the company is the normal trigger to improve safety.								
24	EAC4	+ A	0	0	10	20	30	30
24. The workforce trusts the safety reporting system is fair and just.								

25	LRP9	+ B	0	0	10	15	20	20
25. Senior management considers a broad range of potential safety risks and not just the most statistically probable.								
26	WBL1	+ C	0	0	5	10	15	15
26. Following an accident or an incident, the company attempts to uncover similar threats to its operation.								
27	XRD1	+ A	0	0	10	20	30	30
27. Management constantly discourages any practices that compromise safety.								
28	LRP5	+ C	0	0	5	10	15	15
28. The company is committed to continuous safety improvement.								
29	WBL8	- B	20	15	10	0	0	20
29. Senior management are unaware of the workforces' perception of safety threats.								
30	EAC3	+ C	0	0	5	10	15	15
30. Company staff are encouraged to contribute their operational experience to improve safety processes.								
31	ALS3	+ B	0	0	10	15	20	20
31. Company practices represent a deep concern for safety, which goes far beyond minimal compliance.								
32	MXR2	- A	30	20	10	0	0	30
32. Managers in this company encourage some individuals to take risks that can compromise safety standards.								

33	LRP1	+ A	0	0	10	20	30	30
33. This company has reduced the operational threats of injury or death to as low as practicable.								
34	WBL4	+ C	0	0	5	10	15	15
34. Senior management assesses the company's safety performance using a broad range of assessment techniques.								
35	CAP5	- B	20	15	10	0	0	20
35. In this company, deviations from procedure or rule bending are justified on the grounds of efficiency.								
36	ALS1	- A	30	20	10	0	0	30
36. In practice company activities do not achieve minimum legal compliance.								
37	LRP6	+ B	0	0	10	15	20	20
37. The safety equipment provided by the company is adequately maintained.								
38	ALS5	- A	30	20	10	0	0	30
38. Company safety policy is driven by minimum cost rather than a desire to improve safety standards.								
39	SBR2	- B	20	15	10	0	0	20
39. Bending and breaking some rules is the only way tasks can be completed on time or on budget in this company.								
40	WBL7	- C	15	10	5	0	0	15
40. Company safety staff can only intervene to stop unsafe activity with the approval of the management.								

41	CAP3	- A	30	20	10	0	0	30
41. Company managers do not address emerging threats or risks.								
42	ISC2	- A	30	20	10	0	0	30
42. The company's senior management do not demonstrate commitment to improving safety culture.								
43	ALS4	+ C	0	0	5	10	15	15
43. The company's safety related training goes beyond minimal legal compliance.								
44	EAC1	+ C	0	0	5	10	15	15
44. The company encourages two-way communication about safety issues.								
45	LRP3	+ B	0	0	10	15	20	20
45. Senior management continually introduce safety improvements or initiatives.								
46	XRD4	- B	20	15	10	0	0	20
46. Management ignore practices that compromise safety standards.								
47	SBR3	- C	15	10	5	0	0	15
47. In order to make their job easier, staff adapt procedures to suit themselves.								
48	MXR4	+ B	0	0	10	15	20	20
48. The company offers no incentives to promote excessive risk practices.								
49	SBR4	+ A	0	0	10	20	30	30
49. Staff do not feel compelled to bend or break rules due to pressure from management.								
50	ISC4	- B	20	15	10	0	0	20
50. Staff are not asked for their opinion of the effectiveness of company safety culture.								

Appendix B CURES Application & Correspondence

Cranfield UNIVERSITY

Cranfield University Research Ethics System (CURES)

Part 1: Summary Details

Lead Researcher (Applicant)

Title	First Name	Surname
Mr	Anthony	Lawrenson

School: SATM

Email: a.j.lawrenson@cranfield.ac.uk

Lead Researcher status: (•) Student ( ) Staff

Course Enrolled

PhD

Please confirm which project type your application is supporting

(•) Thesis
( ) Group Project
( ) Other

Co-Researcher

Title	First Name	Surname

School:

Email:

Short title of project

Project ID: 0730

d3SC

Full title of project

Defence of Due Diligence through Safety Culture

Abstract

Following a comprehensive literature review, a model has been developed, which aims to articulate the link between safety culture and potential corporate liability for organisations operating within the commercial aviation sector. A simple algorithm based on the model has been developed and this has become the basis of a piece of software, named 'd3SC'.

d3SC is being developed as part of my PhD research project aiming to identify a legal standard of safety culture within commercial aviation. Its purpose is to articulate particular aspects of safety and risk performance by a complex organisation such as an airline, a maintenance organisation, or an airport into a level of potential liability. The software is designed to provide a graphic representation of the relationship between safety culture and potential liability.

The data is confidential with three broad biographic questions. It is obtained initially by a fifty-point questionnaire followed by a short semi-structured interview where appropriate. It takes approximately 30 minutes to complete the questionnaire. The participant then receives a verbal and pictographic assessment of their own company's safety culture (or the safety culture of the organisation under discussion) and associated potential liability showing no association to either themselves or their organisation.

The research aim is to initially gather data from industry delegates participating of their own free will whilst attending Cranfield based training courses. Once initial benchmarking data has been collated, the process will be used within organisations operating in commercial aviation.

Lead Supervisor

Title	First Name	Surname
Professor	Graham	Braithwaite

School: SATM

Email: g.r.braithwaite@cranfield.ac.uk

If the supervisor details above are missing or incorrect, please contact cures-support@cranfield.ac.uk

Intended start date of project	07/09/2015
Intended end date of project	06/05/2016
Intended start date of data collection	08/09/2015

Please note: you must not begin your research until approval has been given by CURES.

Will the research be sponsored or funded by an external organisation?

- ○ Yes
- ◉ No

Please click on 'Next' in left hand actions bar to move forward to Part 2

Part 2: Ethical Risk

The following questions will help determine the level of ethical risk that your project entails.

Firstly, please give us your own assessment of the ethical risk level of your project. The University has 4 risk levels (see help information). If you have any doubts as to which category is appropriate the higher risk category should be used.

Level 2: Risks to the researcher/participant are no greater than those typically encountered in ordinary life

Please select any that apply:

- ☐ Animals are involved in my research
- ☐ My research involves living organisms/biological agents and could potentially impact other entities outside the laboratory
- ☐ People may be seriously harmed in the course of the research
- ☐ The proposed research could adversely affect the reputation of the university
- ☐ The research data is about illegal activities or will be collected from those engaged in illegal activities, or has itself been collected illegally

- ☑ None of the above

Please select any that apply:

- ☐ The research will involve the collection and use of 'relevant material' under the Human Tissue Act 2004
- ☐ There are significant power differences present, or dual or other complicating relationships exist
- ☐ The research will deal with material that is obscene or violent in content
- ☐ The risk is greater than that experienced by participants in their daily lives
- ☐ The research interacts with members of potentially vulnerable groups (e.g. children, the elderly, those with learning difficulties, prisoners etc.)
- ☐ Harm for participants and/or researchers is likely (physical, emotional, psychological, career, financial)
- ☐ National infrastructure will be impacted negatively (e.g. power grid)

☑ None of the above

Please select any that apply:

☑ Data is gathered from human participants
☐ The project will involve the collection or use of sensitive information, the disclosure of which may cause potential harm
☐ My research has defence or security implications
☐ My research is based on unpublished material

☐ None of the above

Will your research require obtaining informed consent?

◉ Yes
○ No
○ Not applicable

Will participants be able, during the data gathering phase, to freely withdraw or modify their consent and to ask for the destruction of all or part of the data that they have contributed?

◉ Yes
○ No
○ Not applicable

Will your research adhere to the duty of confidentiality?

◉ Yes
○ No
○ Not applicable

Are there any conflicts of interest?

○ Yes
◉ No
○ Not applicable

Please comment on any other ethical issues that may arise from your project

Please click on 'Next' in left hand actions bar to move forward to Part 3

Part 3: Methodology and Expertise

By completing the following information on your research methodology will help us match your application with the most appropriate reviewer(s).

What type of research design will you be using? (tick all that apply)

- ☐ Experimental
- ☐ Quasi-experimental
- ☑ Cross-sectional or survey
- ☐ Longitudinal
- ☐ Case study
- ☑ Comparative
- ☐ Other

What type of research strategy will you employ?

- ◉ Qualitative
- ○ Quantitative
- ○ Mixed methods

Which methods will you be using? (tick all that apply)

- ☐ Experimental - design
- ☐ Experimental - field
- ☐ Experimental - laboratory
- ☐ Randomized controlled trial / other intervention study
- ☑ Interview
- ☐ Observation
- ☑ Focus groups
- ☑ Questionnaires/surveys
- ☐ Action research
- ☐ Personal documents
- ☐ Medical records
- ☑ Literature review
- ☐ Systematic review
- ☐ Secondary data analysis
- ☐ Advisory/consultation/collaborative groups
- ☐ Other

Please describe briefly the population that you will study

Employees of organisations involved in commercial aviation.

How will you evaluate (validate/verify/analyse) your data?

- ☑ I will collect the data and then determine whether there are significant groupings or trends present (information-theoretic models)
- ☐ I will test a hypothesis
- ☐ Other

Please assign your research project to one of the University Themes

Aerospace

Please click on 'Next' in left hand actions bar to move forward to Part 4

Part 4: Specialist Studies

This section relates to research around health and defence topics. For most applications the questions will not be applicable.

Have you ensured that your study complies with The Human Tissue Act 2004 and its nine codes of practice?

- ○ Yes
- ○ No
- ◉ Not applicable

Are you conducting research involving human participants undertaken, funded or sponsored by the Ministry of Defence?

- ○ Yes
- ◉ No

Is the research taking place in or through the National Health Service (NHS)?

- ○ Yes
- ◉ No

Please click on 'Next' in left hand actions bar to move forward to Part 5

Part 5: Supporting Documents

You are encouraged to upload a research protocol if this is common practice in your area of study. In addition, please upload any supporting documents you may have that will help reviewers understand your research design such as questionnaires, interview schedules, participant information sheets, consent forms, case for support etc. (dependent on study)

Type	Name	Date	Version	Size
Supporting Document	A - informed consent briefing	A - informed consent briefing.docx		99.0 KB
Supporting Document	B - Tick to Consent Form	B - Tick to Consent Form.docx		104.3 KB
Supporting Document	C Bio Data Qs	C Bio Data Qs.docx		55.7 KB
Supporting Document	Likhert d3SC Questions	Likhert d3SC Questions.docx		102.2 KB

Please click on 'Next' in left hand actions bar to move forward to Part 6

Part 6: Declarations and Signatures

Researcher Declaration

- The completed form is accurate to the best of my knowledge and belief.
- I undertake to abide by Cranfield University's Ethics Policy in undertaking this project.
- I understand that ethical approval for projects, and that the seeking and obtaining of all other necessary approvals and permissions prior to starting the project is my responsibility.
- I understand that I must not begin the research until I have received approval from the Cranfield University Research Ethics System (CURES).
- I understand that any significant changes that I would like to make to this project after receiving approval from CURES, will require a new application to be submitted.

Researcher Signature

Signed: This form was signed by Mr Anthony Lawrenson (a.j.lawrenson@cranfield.ac.uk) on 27/08/2015 13:18

Supervisor Declaration

- I confirm that I have read and fully support this application and will be acting as the supervisor of the lead researcher (student) for this project.
- I have checked that the application has been completed correctly and is of good quality.
- In my opinion, the proposal is viable.
- I understand that the lead researcher I am supervising must not begin the research until they have received approval from the Cranfield University Research Ethics System (CURES).

Supervisor Signature

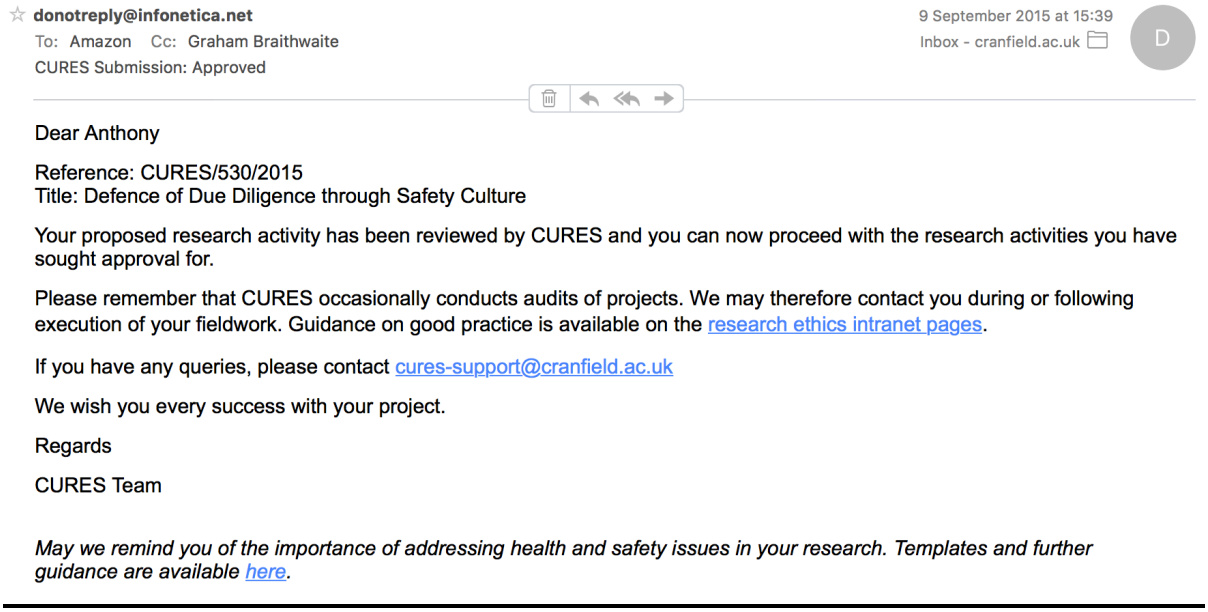
Signed: This form was signed by Professor Graham Braithwaite (g.r.braithwaite@cranfield.ac.uk) on 02/09/2015 14:51

Students must obtain a signature from their supervisor prior to submission

Once both signatures are in place, you may submit the application using the action button in the left hand bar

Cranfield University Research Ethics System – (CURES) Supplementary Information:

1. Approval E-mail:



☆ **donotreply@infonetica.net**
To: Amazon Cc: Graham Braithwaite
CURES Submission: Approved

9 September 2015 at 15:39
Inbox - cranfield.ac.uk

D

Dear Anthony

Reference: CURES/530/2015
Title: Defence of Due Diligence through Safety Culture

Your proposed research activity has been reviewed by CURES and you can now proceed with the research activities you have sought approval for.

Please remember that CURES occasionally conducts audits of projects. We may therefore contact you during or following execution of your fieldwork. Guidance on good practice is available on the research ethics intranet pages.

If you have any queries, please contact cures-support@cranfield.ac.uk

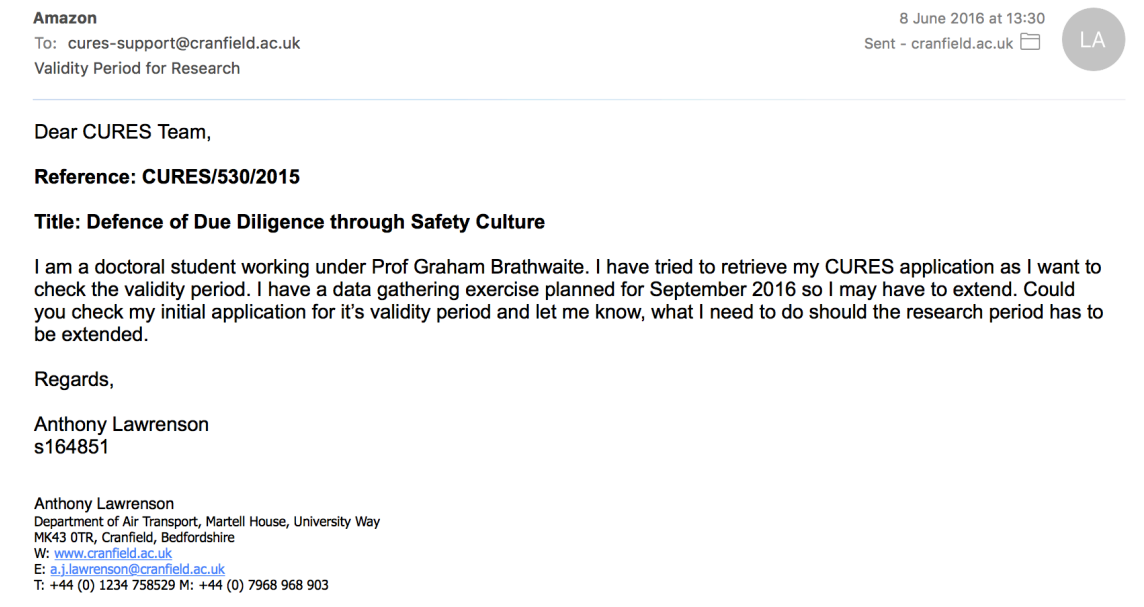
We wish you every success with your project.

Regards

CURES Team

May we remind you of the importance of addressing health and safety issues in your research. Templates and further guidance are available here.

1. Time Extension Request:



Amazon
To: cures-support@cranfield.ac.uk
Validity Period for Research

8 June 2016 at 13:30
Sent - cranfield.ac.uk

LA

Dear CURES Team,

Reference: CURES/530/2015

Title: Defence of Due Diligence through Safety Culture

I am a doctoral student working under Prof Graham Brathwaite. I have tried to retrieve my CURES application as I want to check the validity period. I have a data gathering exercise planned for September 2016 so I may have to extend. Could you check my initial application for it's validity period and let me know, what I need to do should the research period has to be extended.

Regards,

Anthony Lawrenson
s164851

Anthony Lawrenson
Department of Air Transport, Martell House, University Way
MK43 0TR, Cranfield, Bedfordshire
W: www.cranfield.ac.uk
E: a.j.lawrenson@cranfield.ac.uk
T: +44 (0) 1234 758529 M: +44 (0) 7968 968 903

2. Extension Approval:

cures-support
To: Amazon
RE: Validity Period for Research

8 June 2016 at 16:30
Inbox - cranfield.ac.uk

Dear Anthony

Thank you for your email.

Please find attached a downloaded copy of your application for information.

I think as long as nothing has changed since your original application other than the dates there is no issue currently as the dates are "intended" rather than "actual". If your research has changed substantially and your data collection method I would suggest you submit a new application.

Regards

CURES Support 3

See More from Lawrenson, Anthony

Anthony Lawrenson.pdf

3. Informed Consent Briefing:

D3SC INFORMED CONSENT BRIEFING

- Anthony Lawrenson is undertaking this research questionnaire: he is a part-time PhD student based here at the Department of Air Transport at Cranfield University.
- The survey assesses organisation's safety cultures and relates the results to potential traits of organisational liability following an accident. The results are intended to allow organisations to identify attributes which may be developed towards a defence of due diligence.
- You have all been invited to take part in this survey as managers within commercial aviation.
- If you agree to take part in this survey, you may withdraw at any time. If you do decide to withdraw from the survey, you do not have to give a reason.
- If you agree to take part in this survey you will be given an e-mail link to a questionnaire. Following three basic biographical questions, you will then be asked to input a score from 1 to 5 indicating the strength with which you agree with the statement. Scoring a '5' indicates you strongly agree, '1' indicates you strongly disagree. Please read the questions carefully.

- The results will be collated and presented back to you discretely. No individual answers will be identifiable. The resultant information will be merged to represent each group's attitudes and opinions to generate discussion.
- The information will be used for research purposes only and will be accessed only by Cranfield University personnel. It will be stored in compliance with the Data Protection Act (1998).

4. Tick to Consent Version Used in Software:

PARTICIPANT CONSENT FORM

Discreet Participant Number: ☐

Date : ☐

I confirm that I agreed to participate in the research project which has been described to me as:

A likert questionnaire by d3SC voting software and subsequent discussion.

I understand that all personal information that I provide will be treated with the strictest confidence and I have been provided with a participant number to ensure that all raw data remains anonymous.

I understand that although the information I provide will be used by Cranfield University for research purposes, it will not be possible to identify any specific individual from the data reported as a result of this research.

I understand that the data collected will only be used for research purposes as part of doctoral research. The results will be written up as research. I further understand that my raw data will be accessible only to the researcher and the supervising staff at Cranfield University. All data collected will be stored in accordance with the UK Data Protection Act (1998).

I understand that I am free to withdraw from this project at any stage during the session simply by informing a member of the research team, for whom contact details have been provided.

I also understand that by providing my discreet participation number, provided to me, I can also withdraw my data for a period of up to 7 days from today, as after this time it will not be possible to identify my individual data from the aggregated results.

I confirm I have read and completely and fully understand the information provided on this form and therefore give my consent to taking part in this research.

5. Written Consent Version:

PARTICIPANT CONSENT FORM

Participant number: _____

Date: _____

I, _____ (please print your name in block capitals) confirm that I agreed to participate in the safety, risk & law project which has been described to me as:

A likert questionnaire by voting software.

I understand that all personal information that I provide will be treated with the strictest confidence and I have been provided with a participant number to ensure that all raw data remains anonymous.

I understand that although the information I provide will be used by Cranfield University for research purposes, it will not be possible to identify any specific individual from the data reported as a result of this research.

I understand that the data collected will only be used for research purposes as part of doctoral research. The results will be written up as research. I further understand that my raw data will be accessible only to the researcher and the supervising staff at Cranfield

University. All data collected will be stored in accordance with the UK Data Protection Act (1998).

I understand that I am free to withdraw from this project at any stage during the session simply by informing a member of the research team, for whom contact details have been provided. I also understand that I can also withdraw my data for a period of up to 7 days from today, as after this time it will not be possible to identify my individual data from the aggregated results.

I confirm I have read and completely and fully understand the information provided on this form and therefore give my consent to taking part in this research.

Signature: _____ Date: _____

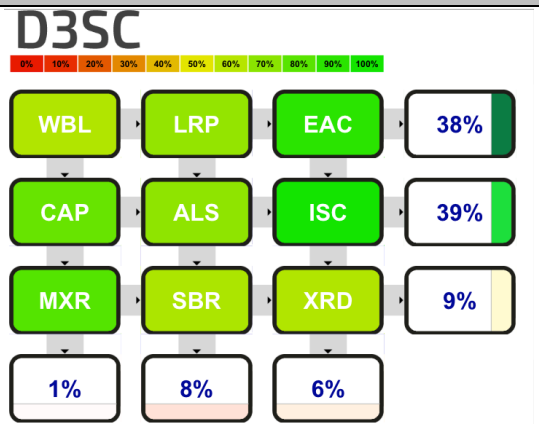
Full name: _____ Contact number: _____

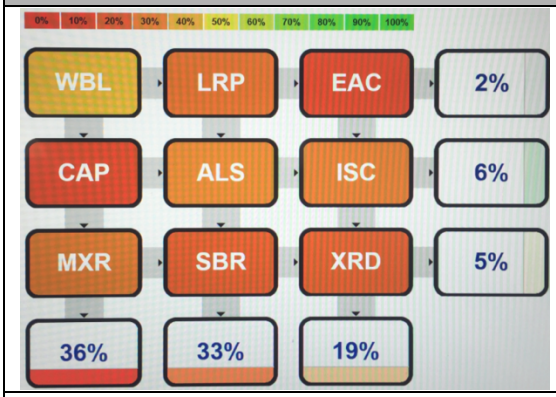
Appendix C Blind Validation Results and Feedback

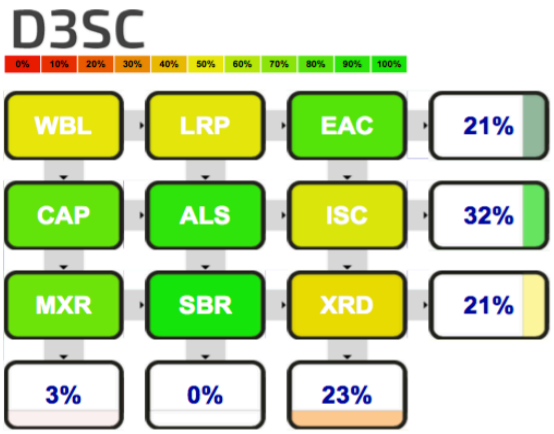
Cranfield University September - December 2015

Individuals present on three independent safety management system and air accident investigators courses at Cranfield University were asked to participate in a trial of d3SC. The participants were each given a 24-hour window to access the online survey through a unique 'event' access code. Eleven replies were received. The survey consisted of a 50 question, 5-point scale, Likert questionnaire. The output of the online survey is the colour coded matrix of d3SC, surrounded by a percentage probability, segregated into six ascending areas of potential corporate liability (PCL). Each of the nine boxes in the matrix has a coded attribute of safety culture described earlier in the chapter. Values are assigned through targeted questions within the questionnaire (see algorithm description). The participants could see the colour coded output of their questionnaire and emailed a screen shot of the output to gain an interpretation from the researcher. A written interpretation was then returned to the participant with a request to mark the accuracy of the interpretation out of 10 maximum points and provide written feedback and comments about the accuracy of the interpretation.

Participant 1	
	**Accuracy Score = 10/10**
Reseacher's Interpreation	Paticipant's Accuracy Assesment
Your answers would suggest the organisation has a relatively strong safety culture. This stems from active risk control of acceptable levels of safety. There is senior management buy-in to developing safety culture, although this has room for improvement. Other improvements could also focus on bringing the operational workforce in to line with organisational safety policy and re-enforcing the discouragement of excessive risk practices. Although there is some evidence of the development of sub-cultures and operational rule-breaking, these areas are not widespread and therefore not of immediate organisational concern.	You are extremely accurate. I would grade your report as a 10. The only very minor issue is the comment regarding the development of sub cultures within the organisation. It's a [redacted] aircraft airline based in [redacted] and we have always had a range of different cultures amongst out pilot workforce, so these have existed from the start. For this reason, the management have always had a very strong policy of adherence to SOPs. This however, does not always work, for as you know, pilot alpha male stereotypes will rebel against such a culture if too heavily enforced.

Participant 2	
	**Accuracy Score = 9/10**
Reseacher's Interpretation	Paticipant's Accuracy Assesment
Your answers describe a strong and improving safety culture driven by engaged employees. There is some evidence of rule or SOP violation, but this is not a strong feature. Areas for improvement would appear to be with further commitment and engagement in safety management from senior management. Although there is no suggestion of any encouragement of excessive risk taking, there could be more active discouragement of rule infringement and excessive risk taking.	The assessment is pretty accurate. I have a minor reservation about excessive risk taking being discouraged, but would grade accuracy as 9/10. The [redacted] operate in a difficult environment with our pilots facing particular challenges. They are very aware of the risks, perhaps more so than their supervisors as they spend considerable time away from their home base.

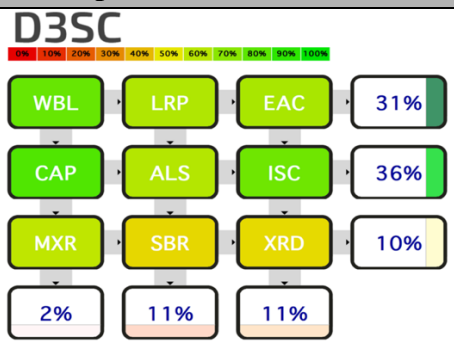
Participant 3	
	Accuracy Score = 10/10
Reseacher's Interpretation	Paticipant's Accuracy Assesment
Your answers would suggest the organisation has a considerable number of areas of safety culture need to be addressed. The most obvious is the tension between senior management policy and practice and attitudes at operational level. There are significant areas of operation which align themselves with the principles of various sub-cultures within the organisation which do not comply with organisational safety policy. There are efforts to improve safety culture and discourage excessive risk taking but these have shown only marginal improvements.	*Thanks, this is 10 grade. If [redacted] need more assessment what do I need to do?*

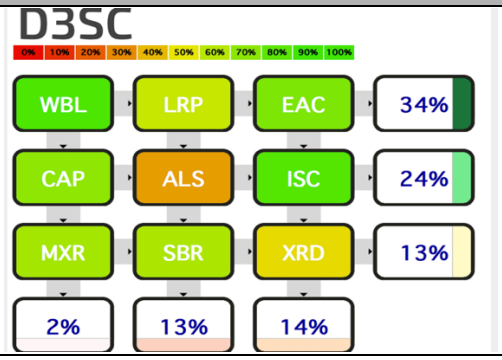
Participant 4	
	Accuracy Score = 8/10
Reseacher's Interpretation	Paticipant's Accuracy Assesment
Your answers would suggest the organisation has several areas of safety culture which could be improved. The most important issue is an inconsistent message from senior management vis-a-vis the promotion of the espoused values of the organisation with those of best practice safety management (for commercial aviation). This results in the way organisational risk management is implemented; the ALARP principles appear to be occasionally stretched. The organisation has not made sufficient effort to improve safety culture within the organisation, however there seems to be an alignment of employee attitudes with the way senior managers do business. The stronger elements of the organisation's safety culture are the way acceptable levels of risk are managed; this could be to do with the operational environment in which the organisation operates.	*I would place the outcome at a grade of 8 with regard to my interpretation of the organisational culture. The adages I would use are:* *- "being seen to do something is more important that actually doing it".* *- "It is all about protecting the* [redacted] *of those at the top, as a reaction to the corporate risk".* *thanks for the feedback.*

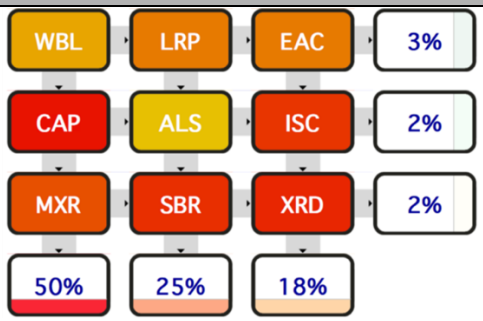
Participant 5	
	Accuracy Score = 9/10
Reseacher's Interpretation	Paticipant's Accuracy Assesment
There would appear to be active risk control at (policy) senior and (operational) middle management level. Excessive risk taking on the line was not encouraged however, significantly, it was not actively discouraged by management or peer intervention. One symptom of this state of affairs, was consistent rule-breaking during line operations and identifiable sub-cultures with differing values and attitudes, forming within the organisation. There have been efforts to improve safety culture, however, the majority view of the line community didn't not reflect or adapt the espoused values and attitudes of company management.	*This about sums up* [redacted]. *We operated a fleet of* [redacted], [redacted] & [redacted] *and my position for the majority of my time there was as* [redacted]. *We attempted a number of programs to improve reporting rates with limited success. I felt that in the majority, the programs were not taken seriously by management or the line community. I would score the accuracy of the assessment at 9.*

Participant 6	
	Accuracy Score = 7.5/10
Reseacher's Interpretation	Paticipant's Accuracy Assesment
Your answers would suggest the organisation has a reasonable safety culture but with distinct areas for improvement. The organisation's senior management have demonstrated a commitment to maintain the espoused values of company policy however it has failed to effectively promote these values at operational level. There would appear to have been a campaign or program to develop or improve the standard of safety culture, however, this has been attempted without an underlying belief by employees in company risk and safety policy. This may have been the result of an inadequate promotion of safety culture foundations, such as Just Culture or inconsistencies in senior management safety commitment messages. There is strong evidence that within the organisation, of the development of sub-cultures which in turn have led to the tacit or even direct encouragement of excessive risk practices at operational level. These features have been identified in organisations with vast differentials in professional specialties or geographic separation; typically appearing in the aftermath of significant company mergers or following the acquisition of smaller companies with their own distinct culture.	*Dear* [redacted] *Thanks for the assessment. Your assessment is correct.* *The scale is between 7 and 8* *Presently I cannot speak for the organisation.* *Will consult with my superior and get back to you.*

Participant 7	
	Accuracy Score = 9.5/10
Reseacher's Interpretation	Paticipant's Accuracy Assesment
Your answers would suggest the organisation has a moderately strong safety culture with some distinct areas for improvement. The strongest area of the organisation's safety culture attributes is the commitment at senior management level to implement and maintain industry best practice. Whilst not up to the safety risk management and legal defence standards of ALARP there is an adequate standard of risk management. Overall, the espoused values and attitudes of senior management have been adopted at operational level. The issues worthy of attention seem to revolve around operational risk management, generally associated with middle management practice. There is minor evidence of tacit support for excessive risk practices and tolerance of sub-culture practice; the result is evidence of deviance from SOPs and policies at operational level.	*I think that analysis is worth a 9, nearly a 10. The bit I see is breaking rules, it's an issue for us, definitely.*

Participant 8	
	Accuracy Score = 8/10
Reseacher's Interpretation	Paticipant's Accuracy Assesment
The safety culture you have described is moderately strong and shows some signs of improvement. Senior management have attempted to improve the alignment between their aspirations and the operational staff. They have done well with the frontline workforce having got considerable buy-in. There is however, work to be done with middle management. Rule-breaking on the frontline is an issue and more could be done to dissuade excessive risk practices amongst front line staff.	*I think you are fairly close to how I see it, my most recent experience was working in* [redacted] *as part of* [redacted] *where we were required to deal with* [redacted] *project teams and* [redacted] *staff where, my opinion, lack complete the depth of work required. It's not all bad but the development of necessary* [redacted] *will take some time and probably needs clear focus and maybe a change in mindset for hi tech avionics and complex software. My broader thoughts and experience may have leached into the assessment a bit, difficult to dump nearly 30 yrs and concentrate on only one area. Also, there are many complex personality related considerations in any overall safety assessment, we may not flush these out and fully understand how they might impact until we get something to baseline ALARP. Fighting against high levels of technical and functional safety knowledge in management and challenging lack of knowledge were problems. I suppose I would characterise it as a lot of good people doing lots of work probably under resourced and not being able to what they probably know they should.*

Participant 9	
	Accuracy Score = 9/10
Reseacher's Interpretation	Paticipant's Accuracy Assesment
Your answers would suggest the organisation has a reasonable safety culture but with some areas for improvement. The organisation's senior management have demonstrated a commitment to maintain the espoused values of company policy however it has failed to effectively promote these values in the way operational risk management has been implemented. This is demonstrated in a differentiation between policy and actual risk management. This is prevalent throughout the organisation but particularly at operational management level. It would suggest the wrong messages are being sent from the upper managerial levels or these messages are just being misinterpreted by middle managers, with a larger and occasionally inappropriate risk appetite. An absence of active discouragement by senior management, of excessive risk practices is the most obvious initial area for improvement. The next and more long-term approach would be training for middle management in safety and risk management practice.	*I think you hit the nail on the head. Middle management. Always the guys in the office spinning plates and trying to get through the day is where it falls down. Everybody wants things to get better but nobody has the time. 9 out of 10. Nice job.*

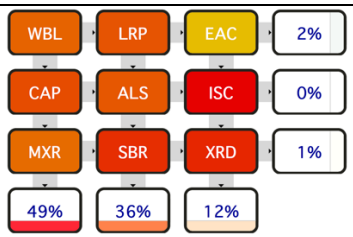
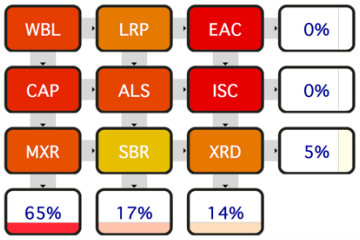
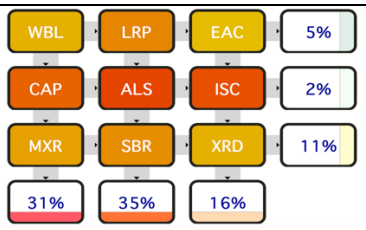
Participant 10	
	Accuracy Score = 8/10
Reseacher's Interpretation	Paticipant's Accuracy Assesment
The safety culture of the organisation you referred to in your questionnaire has marked and significant issues. The characteristics you described place the organisation in a rather vulnerable position should they be involved in an accident or subjected to a thorough assessment of their Safety Management Systems. The most significant characteristics are the development of sub-cultures within the organisation who engage in their own accepted practices. These practices would appear to be common and involve regular breaches of SOPs and regular rule-breaking. Rather more concerning is the tacit support by management of excessive risk practices. These activities have not been challenged by management nor is there evidence of any significant or effective efforts to improve and develop safety culture. It would appear, looking at the whole assessment, many of the issues are the result of weak or ineffective management at senior level, although this is partially mitigated by some efforts made by middle-management staff who have attempted to improve the status quo.	*It's been a difficult few months and the issues have not gone away. Things are improving, you think, then it just gets worse again. I think you would have to see some stuff for yourself before you understand. Its culture for sure but some or rather one or two individuals really swing the lead to keep the operation going.*

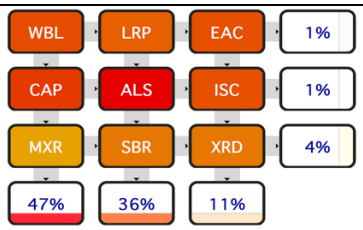
Participant 11	
	Accuracy Score = 8/10
Reseacher's Interpretation	Paticipant's Accuracy Assesment
The organisation's senior management have demonstrated some commitment to maintain the espoused values of company policy however it has failed to effectively promote these values in the way operational risk management has been implemented. It has also had limited success in bringing employees in line with its ambition for your organisation's safety culture. There is a moderate alignment with senior management policy and day-to-day operational risk management but there is certainly room for improvement. Perhaps most significantly, rule-breaking and SOP violation is insufficiently challenged at operational level. This could be from tacit encouragement from senior managers but more likely, looking at the lack of buy in of employee attitudes to company safety policy within the organisation, an absence of directly challenging and discouragement of violations within your safety culture.	*I think you are very close to the actual (my perception) situation in my organisation, and I would give your assessment a rating of 8 for accuracy.* *The information you provide will give us something to take back and work on, so thanks so much for the beneficial assessment.*

Appendix D Accidents Interpreted by d3SC

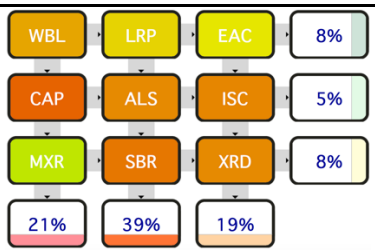
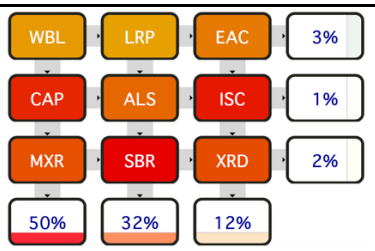
Part One: A Review of Significant High Profile Accidents Interpreted by d3SC

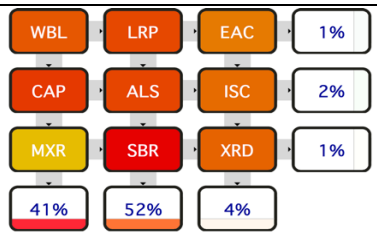
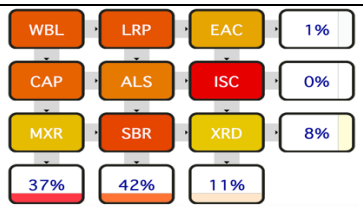
Incident, Year & Fatalities	d3SC Description	Researcher's Interpretation
Chernobyl Nuclear Reactor Meltdown 1986: Approximately 60 initial deaths.		Low scores across the top line suggest there was no effective safety culture at Chernobyl. Local management were left with sometimes limited resources to maintain the site productivity. Pressure from government staff (MXR) was probably the main motivator to break procedure in order to present a working reactor to government officials giving low CAP and no resources (or political will) to develop safety culture (ISC) and reduce SOP breach (SBR).
Challenger Space Shuttle Launch Accident, 1986: 7 Fatalities.		There is no doubt as to the commitment of NASA's workforce to achieving excellence. However, low scoring CAP suggests that commitment may well have contributed to the launch decision. Given the pressure NASA were placed under to launch, the question becomes whether NASA's safety culture was appropriately robust to resist that level of external pressure to bend or break rules to launch.
Sinking of the Herald of Free Enterprise, 1987: 193 Fatalities.		The low scoring mirrors how P&O were criticised during the investigation into the sinking. Senior management showed very little regard for safety matters, even after the accident. The remote workforce were reliant on their immediate working groups for setting standards of safety behaviour. The operational failures & causes of the sinking were prevent elsewhere in the company and in other operators.
Explosion of the Piper Alpha Oil Rig, 1988: 167 Fatalities.		Keeping the production of the rig going during reconstruction work seems to have allowed the immediate cause of the accident. Senior management also set the standard of how safety was going to be prioritised: low WBL & LRP. Workarounds and short cuts resulted which eventually led to the gas explosion. ISC & XRD suggest that the staff considered that safety standards were reducing and not improving.

Kings Cross Underground Fire, 1987: 31 Fatalities.		As there had been no tube station fires in recent memory, the threat did not appear in the station's risk assessment. The lack of commitment from senior management, WBL and lack of communication to the workforce, EAC is apparent and translates to complacency. Without appropriate training, staff adopted common & accepted practices that did not consider the level of threat from an underground fire.
Explosion of the Piper Alpha Oil Rig, 1988: 167 Fatalities.		Keeping the production of the rig going during reconstruction work seems to have allowed the immediate cause of the accident. Senior management also set the standard of how safety was going to be prioritised: low WBL & LRP. Workarounds and short cuts resulted which eventually led to the gas explosion. ISC & XRD suggest that the staff considered that safety standards were reducing and not improving.
Clapham Rail Crash, 1988: 35 Fatalities.		This example shows a direct causal relationship with senior management incentivising short cuts and work-arounds. In this case, the level of voluntary overtime meant there was no time for training or safety assessment. The EAC score and ISC is therefore reduced. Although the signalling error was directly caused by a wiring error, staff were not overtly breaking rules but a climate had developed were error was likely.
The Westray Mining Explosion, Novia Scotia, 1992: 26 Fatalities		There is little to say that is positive in the Richards report into the Westray mining disaster. This is mirrored in the d3SC output. The principle that using open flame torches in a confined space is poor practice, but then to reprimand those who report the procedure as dangerous becomes something of an anathema to the principles of effective safety culture.
Ladbroke Grove Rail Crash, 1999: 31 Fatalities.		The d3SC report shows a strong tendency at middle management level to cope with low resources. Senior management seem to have safety in mind but this is not translated into their management of risk. The resulting low score of CAP, ALS and ISC suggest stretched company resources. In the case of the Ladbroke crash this was predominantly around the quality of driver training and dealing with poor signalling.

Hatfield Rail Crash, 2000: **4 Fatalities.**		Whilst the company were not directly incentivising staff to break rules to improve efficiencies d3Sc does suggest that the company allowed operational risk to fall below an acceptable level. The low ALS score suggests that through ineffective management of rail maintenance was tolerated (CAP). The Cullen report suggest senior management were aware of deficiencies but failed to act (low WBL).
Columbia Space Shuttle in-flight break-up, 2003: **7 Fatalities.**		The primary issue highlighted in the report is the incentivising of risk. Whilst there is only marginal evidence of rule breaking, in SBR, this is coupled with a low scoring ALS. This might indicate a middle management trying to balance safety and resource. Coupled with the low scores for MXR and XRD, a culture of 'press-on regardless' is emerging. In the Columbia case this is manifest in the adoption of new ice damage procedures on the booster rocket.
Loss of Nimrod XV230 in Afghanistan, 2006: **14 Fatalities**		The output suggests a loyal workforce (EAC) but weak leadership (WBL). The institutional drive to keep operations moving allowed compromise throughout the organisation. The low LRP score suggests that senior management did not engage their risk practice to constantly reduce risk. Operational staff are not directly addressed with an incentive to operate but are confronted with a compelling inertia to get on with the job & results in rule breaking: SBR.
Explosion of the BP Deepwater Horizon Oil Rig, 2010: **11 Fatalities.**		The notable feature is the green ALS. Despite management exceeding levels of tolerable risk, the d3SC perspective interprets the company's relationship with the regulator MMS as a positive indicator. The company fail in two areas: allowing a sub-culture of high risk to develop & not communicating the safety message. The immediate cause of the accident was on board the rig but the strongest cultural drivers were embedded in a strong company culture that drove production above all else.
Meltdown of the Fukushima Nuclear Reactor, 2011: **0 Fatalities from immediate and direct exposure to radiation.**		The organisational culture is driven from top down with high levels of compliance confirmed by a high SBR score. Senior management has not applied appropriate risk practices and ignored safety concerns by narrowing their risk assessment procedures. Production pressures are likely to have influenced the low CAP score suggesting compromise solutions have been applied to safety management.

Part Two: A Review of Significant Commercial Aviation Accidents Interpreted by d3SC

Air Inter Flight 148, Strasbourg, 1992: 87 Fatalities.		The one specific area the senior management of the company did not address is the emergence of lax operational standards across middle management. This is possibly driven by sub-cultures, operating away from company SOP. It has led to some rule and SOP breaking on the line. None of this activity is encouraged and quite possibility it is discouraged but it has been allowed to develop and has deteriorated company safety culture.
ValuJet Flight 562, Florida 1996, 110 Fatalities.		Senior management have failed to appropriately address how company safety and risk policy has been applied to operational issues. As a result, ALS score low and a low SBR indicate SOP and rule breaking is prevalent. ValueJet were rapidly expanding their operation at the time of the accident which might explain a lack of company resources aimed a safety training and developing company safety culture.
Alaska Airlines Flight 261, California, 2000: 88 Fatalities		Senior management appear to have the will but lack the drive to implement improvements to safety culture within the company. There is some evidence of compromised risk management at higher levels in the company. Rule breaking on the line suggests that although staff recognise efforts to improve safety culture this has not yet translated into improved operational standards.
Air France, AFR 4590, Concorde F-BTSC, Paris, 2000: 113 Fatalities.		The overall pattern describes a lack of senior leadership in implementing adequate operational safety standards in this company (low WBL & LRP). The staff are supportive of company policy (EAC) but common practice away from company SOPs has been allowed to develop to become the norm. The low operational standards leave the organisation vulnerable to human error and adverse conditions.
Crossair Flight LX 3597 Crossair Avro RJ100, Zurich, 2001: 10 Fatalities.		The marked feature of this organisation is the dominance of sub-culture behaviour, CAP. There is a deteriorating safety culture, ISC and significant rule-breaking: SBR. Lack of commitment at senior management level has allowed this situation to evolve. In Crossair's case, recent merger activity had left different fleets with very different cultures. Reporting safety events was not supported by management therefore avoided by staff.

DHL B757 collision with Bashkrian Airlines Tu154, Uberlingen, 2002, 71 Fatalities		The d3Sc output suggests Skyguide's management lacked some commitment to safety issues from low scores across the top line. Company procedures are generally followed, (CAP, SBR). But safety is not sufficiently driven as a company principle (XRD). Incentives to continue operations under scarce resource is suggested by ALS. Lax efforts to improve safety culture, ISC also suggest low resources.
Platinum Jet, Challenger CL-600, Teterboro Airport in New Jersey, 2005. 0 Fatalities		The obvious feature at senior management level is a significant lack of organisational leadership in safety issues. The most marked feature at operational level is the low scoring SBR. Management have allowed the development of a culture were rule breaking has become a normal event. CAP suggests that this as sub-cultures have emerged on the back of poor management influence.
Helios Airways Flight HCY 522, Boeing 737-31S, near Athens: 2005. 121 Fatalities		Lax commitment from senior management represented in WBL and LRP has failed to improve safety culture, ISC. The score is low enough to suggest the culture is deteriorating. As there is little opportunity for feedback into any SMS, management may not be aware of rule breaking at operational level, SBR.
Mid-air collision of a EMB-135 Legacy business jet and a GOL Airlines B737 8EH in Brazil: 2006. 154 Fatalities		Employee attitudes to safety are aligned with senior managements. However, the lack application of addressing sub-culture behaviour (CAP) and a failure to improve safety culture (ISC) suggests a lax style of safety management. There is little to no discouragement of excessive risk practices which supports a low level of engagement in operational issues by company management.
TAM Airlines Flight 3054 Sao Paolo Congonhas Airport, 2007 199 Fatalities		The obvious discontinuity in the report is between senior management commitment to safety and a poor if not deteriorating safety culture, ISC. The low scoring EAC suggest there are communication issues between senior management and the workforce. Although not problems as stand-alone attributes, these scores have influenced CAP and SBR suggesting operational standards are vulnerable to compromise.
Spanair Flight 5022 accident at Madrid Barajas Airport: 2008 154 Fatalities		Low commitment from senior management seems to have affected the low ALS score. The company's operational standards are reflected here and this allows low SBR, or rule breaking. The low score for ISC suggests that little commitment was given to developing the company's safety culture. Similarly, insufficient resources were allocated to improving overall operational standards. This overall low priority given to safety was directly implicated in the accident.

Collision of Scandinavian Airlines System Flight 686 with a Cessna Citation at the Linate Airport in Milan, 2001. 118 Fatalities		Limited drive by senior management to engage with their staff is apparent (EAC). There is further evidence that has contributed to a poor safety culture. There is a lack of commitment from management to improve this situation and the low XRD suggest a lack of incentive to challenge high risk practices at operational level. SOPs and rules are broken to facilitate efficiencies rather than improve safety.
Loss of Air France 447, F-GZCP, South Atlantic, 2009: 298 Fatalities.		The ALS score suggest operating standards were generally upheld and gave no suggestion of management incentivising excessive risk practices. The top line attributes that are normally associated with senior management suggest whilst there were some effort to develop safety culture, it was compromised. There is no recognised improvement in safety culture by employees. The low CAP scoring indicates that sub-culture behaviour and SOP breaches are issues that senior management failed to address.

Appendix E Senior Managers Semi-Structured Interviews (A)

Before the interview began, brief explanation of the process was given with an explanation of the scoring method for the analysis. The manager was then asked to read the interpretation of the results and assess the accuracy of the analysis. The accuracy was scored by a simple 1 to 10 scale. 1 being an inaccurate description of the attitudes of the sample group and 10 being an exact accurate description.

A further narrative comment was requested to back up the score to validate the score was used in the correct sense and to discourage tending to the mean. The interviewee was asked to provide up to three areas he felt drove his interpretation of the accuracy score. All the interviewee's responses are in italics.

Question 1:
What is the accuracy of the analysis a) as a number between 1-10 b) as a brief description?

Question 2:
What are the three major features that drove your accuracy score?

A1 – SENIOR MANAGER INTERVIEW: 13TH APRIL 2017		
DEPTS D3SC	**ANS 1**	**ANSWER 2**
ALL	6	Very accurate in elements. Safety Culture is continually improving. I see that everywhere in the network. Definitely. Excessive Risk practices are not incentivised by management. It's just not the way we run our business. I agree with the fact that more work needs to be done with employee attitudes to align with senior manager's attitudes to safety. That's where we can make some real gains.
A	6	Again, very accurate in elements. Safety Culture is improving we know that but we cannot fast track safety. That's where things go wrong. You can't just drag people into this process. They kick back. There is a perceived lack of trust between the unit and senior management. You feel this not so much see it. It's just a feeling you get when we run these programmes and training. Local management attitudes differ from attitudes at senior and corporate level. It's part of the way XXXX works. We know things can differ from one [department]to another. That's just XXXX.

DEPTS	ANS 1	ANSWER 2
B	8	The report is very accurate in most content. We work hard to encourage it but yep… The safety culture is strong. There is an authentic senior management commitment to safety issues. There just is. I am lucky to be able to see it rather than just take somebody else's word or idea about what it is. Improving safety culture recognised by the operations guys, by the workforce.
C	5	I'd say its accurate in some parts. But I don't see a lot of what's described. I'm not saying there's not something going on that needs… well looking at. Its saying that there are vulnerabilities in safety culture across both workforce and management levels that are not apparent to me. I do however recognise there are relationship issues between management and operational staff. I do think managerial opinion on safety improvement is not strongly felt at operational level. They don't get it or we are just not getting the message across.
D	9	There is an excellent safety culture. This description is authentic almost in total. This is what I see on the ground floor. The good score is advocated by workforce, which is true. That's what makes this real it's not management saying this stuff but the guys. As it says: attitudes among the workforce are compatible with the wider company. Yeah this is a better description of, well, across the board safety culture here. That's my opinion, that's what I see.
E	7	Yeah, it's pretty accurate in the majority of elements. We have a strong and improving safety culture. It's because how we prioritise. Safety and risk practices are of a high level. Guys on the line, they see a very different department. They see sometimes what they want to and sometimes, in some [departments]what they told to see.
FURTHER COMMENTS		There was a real issue with '3C'. I know the individuals concerned and it didn't tie up with what I see. A lot of what was related (in the report) didn't make sense at first until we realised who was there at the time. There have been a lot of changes now and I think there is not the same attitude to management that we saw then. He's gone.

A2– SENIOR MANAGER INTERVIEW: 19th APRIL 2017		
DEPTS	**ANS 1**	**ANSWER 2**
ALL	7	Given the company there some staff changes at least within one of the location and that may have been factor. This applies to rule breaking and lack of SOP maybe because they came from different airports and were used to different procedures. Also, discussion surround the table there were works arounds always going on to tweak the operation. This creates bottlenecks where senior management may think things are lovely… but it doesn't always filter down or up the organisation. From the senior manager side, we are closer to the coal face of risk management than most operators. Things are improving. We do however, have a more flowery description and view of safety and risk than the average guy on line.
A	7	The physical distance from the centre and potentially different approach to how process can be applied affected the scoring. Not necessarily corner cutting, but different interpretation of SOPS. Looking at personal relationships, now that could have potentially skewed the image of the safety culture senior management is trying to promote. There is a perception out there that middle and senior management are trying to promote better safety culture but the airport staff feel that cost cutting is an element of that. That even comes from some of the manager's meetings and looking at the bottlenecks of communication the information can be misinterpreted.
B	8	I think it's there. I would be of the view that safety culture is improving. If its honest feedback – it's the only way I can assess feedback- it would suggest the safety culture is fairly strong. I think that airport staff believe there is commitment from the company but looking at how the operation is delivered there are areas of operation and SOPS where there are work arounds and we accept that from my discipline. It reflected in the work that we do. They would see the same thing in the analysis. Although there is work to try to change the procedures or understand why they take place.
C	3	I don't see in this, not in terms of processes compared to the system that we have for intelligence gathering. This does not reflect the intelligence we are receiving from other sources. If it is as bad as this then we should be seeing some evidence of systems break down, somewhere. I do accept there are areas of break-down in communications between senior management and staff.

DEPTS	ANS 1	ANSWER 2
D	8	This is the sort of feedback I get from staff. If you think where we have come from… where we were 7-8 years ago in terms of culture. The vast majority of them… that's what we get. I'm not saying across every airport we get it right. The environment would suggest that's a better reflector of the culture. Its right that potentially there is a discouragement that we discourage excessive risk practices… we ponder long and hard around risk but there are some cultural changes required on risk perception but we are working on those now.
E	6	I think its reasonably accurate in that we have…I don't see that we have a low commitment to safety from senior management. That would be one element of what my overall view of this would be. We may be suffering from a lack of or poor communication and bottlenecking again. There is evidence of an improving safety culture but there are still elements of transgressions from SOPs. That's where we know where we are. Also, I wouldn't necessarily agree with cost cutting and rule bending. We are trying to increase efficiencies but not encourage rule bending. No, that's not the idea.
FURTHER COMMENTS		There is a perception that our policy and safety management constantly seeks feedback, but it tends not to get fed back, right down into the depths of the workforce. There are some elements I do agree with about operational policy. There is a correlation here although we try to get to the operational guys but we don't always get there. The generic comments are fair. This was done at a specific time and there may have been forces that skewed the risk perception. That could go both ways. I would hope if we ran it again we would see an improving picture. I liked the roadmap picture to show were we need to spend more time researching why this picture is emerging.

A3– SENIOR MANAGER INTERVIEW: 19th APRIL 2017		
DEPTS	**ANS 1**	**ANSWER 2**
ALL	7	I think I agree that safety culture is improving and tend to agree that there is disparity of management versus operational staff. There is a definite bottle neck between them and us. There are different perspectives between the two groups. The operational frontline and senior management trying to get the communication lined up particularly with the topography of the organisation and the community cultures are different. There is a completely different view of life between those in the north and south and west. They're all different.
A	8	Predominantly focussing on workforce trust, it's between workforce and management rather than senior management. The strength of the local manager is probably the biggest bottleneck. I'm thinking about attitude and behaviour and how things are translated by him and explained to the coalface. When you go to speak to these people at the coal face its quite staggering. That has not come from anyone at senior management level. Depending on the leadership style and impact of that manager that has a huge impact on those at the sharp end. Again, I thought it was really interesting. The last sentence would suggest that the whole department is resistant to senior management intervention. If the message is conveyed negatively then that the way it's received. Because it's a small department they are very receptive to what is said at local management level.
B	7	So, this was on the basis that the safety culture is strong. In terms of my knowledge of this department they are very regimented. They don't do it because they are told to do it, but because they understand that's how to do it. They don't deviate. Listening to how they speak is very safety focussed. The disconnect is between senior management and the sharp end.
C	7	Okay, this department are a really, really, strong bunch of characters. Almost to the extent that the tail wags the dog. Very opinionated. All it takes is one thing. The safety climate changes very quickly. Probably going back some time ago there was an investigation as they all do for input. The input from senior management was put back to the department. All it took was a couple of words that were misinterpreted for the department to suggest this was XXXX [senior management] pointing the

		finger at us. There is a really strong 'them and us' feel about it. You can feel it.

DEPTS	ANS 1	ANSWER 2
D	9	The basis of the high score is the strength of the middle manager and the alignment of his thoughts with senior management. He is very, very, proactive in developing safety and promoting safety training on the department. You walk into the department and you get that feel. Yep. Really accurate assessment.
E	8	In relation to the distance again a big player. Distant and very small department and tight community. The feeling that how dare senior management interfere with our operation. My thoughts are very similar to department A. I think that's is probably it.
FURTHER COMMENTS		I think probably my overall comment is in the process of over two years its interesting how my opinion has changed. Going from senior management down to the shop floor it's interesting to see what all the changes have happened. It has crystallised my perception of the bottleneck. The latent issue is with the bottleneck. Different place cultures not just safety culture. Communications are a full-time job. As soon as you stop communication then the misperceptions start and it all slips off.

Appendix F Department Managers Interviews (B)

Question 1:

Referring to the assessment of the overall safety culture assessment carried out in December 2016, how would you score the accuracy of the summary from 1-10? (10 being a highly accurate description of the department safety culture and 1 being a highly inaccurate description of the department).

Question 2:

What are the three major features that drove your accuracy score?

B1 – AIRAMP-3 TELEPHONE INTERVIEW NO 1: 11:30 21st APRIL 2017	
Answer 1:	Score*: 7.*
Answer 2:	*What drove my thinking was that there are people in the team that would want to put management in a bad light. There is just an element that would want the scoring to be lower for nothing more than devilment. The score could have been higher, but I didn't want to let that element have an influence. The majority would have answered the questions openly and honestly. This also applies right across all the other departments. All organisations have this sort of thing to contend with. These sorts of answers skewed the results. I felt very relaxed about putting my own staff forward for the survey. Again, all organisations have these sorts of issues to deal with. The overall result and reading though the other departments it seems a fair reflection. I couldn't have picked which of the departments was actually mine from the survey results. I am not concerned that we didn't have the process in place, in fact I am confident that it's all there ready to go. The fear, no concern, that I have is that we don't have the right sort of training to represent us. The sort of training that would put the company in a bad light; that sort of training is (I think) only given to the higher levels of management. This should be given at departmental level; How to represent us in a court of law. Any decent lawyer would just rip you to pieces in a court. In you go. That's it, over. We had an incident near one of the (departments) when a guy died. The information was just passed about the weather, nothing to do with the rescue and in he goes (the individual). He said afterwards that he didn't feel well-enough prepared to deal with being in court and to represent the company in a favourable light. He felt he was no-where near well trained enough to leave the company portrayed in a reasonable light. Further corporate support and training would at least improve confidence in how we do our job like a lot of our guys further up the management chain. They get it. They get the training. Why don't we?*

B2 – AIRAMP-3 TELEPHONE INTERVIEW NO 2: 12:00 28TH APRIL 2017	
Answer 1:	Score*: 8.*
Answer 2:	*The process itself and confidentially feeds into the accuracy. People can speak freely into the survey and questionnaire. The second is the spread of the research. The scope of it from board down to the troops on the ground. You can ask the board all day about safety culture and safety management but they are so far removed from the troops on the ground. I can sit and write a procedure but it's not going to work. The reason for not giving 9 or 10 no matter who your research subjects you always get an element of people grinding axes or doubt the confidentiality you always get these people and can't do anything about them. I can see what you have written is reflective of what happens. Sitting in the office you think it's happening. We are so stretched its so difficult to take time and watch what's actually going out on the line. We are infinitely better than where we were when XXX* (a corporate manager) *took it by the scruff of the neck. we have discussed this many times. We are not looking for no blame but we need culpability. We found FOD* (foreign object damage) *on the runway and has been running for months. The word on the street in this department was that you just threw FOD away into the grass and forgot about it. Slight issue with some of the reporting that has gone on out of control. An incident occurred where a bracket sheared but there were not enough resources to do the job of investigating; we are not out of the woods yet. It's now a major part of our job. We are not there yet but, the changing culture within senior management is night and day. This is an ongoing battle but the troops seeing some managers taking this issue of reporting on at corporate level. That's encouraged change. We are constantly firefighting day in day out due to resources. I struggle at times to put in mitigation. You can't mitigate against stupidity. A safety critical employee just walked off the job with an aircraft inbound. What do you do?s Rarely now we turn to mitigation as a tick box exercise. The head office culture was just wrong. People didn't report because heads of corporate were all over it like a rash. The stations weren't reporting because it felt like every manager was waiting to pounce. Now that everyone is reporting there is now more targeting reporting which allows a better use resources. We are a lot better than where we were in 2012. I have slightly different standpoint from the safety culture at my partner's organisation. They are really top heavy and process orientated with very rigorous procedure's they are black and white. It's the way forward to push this. But we cannot write SOPS for every eventuality. We need work arounds just to get the job done. The other organisation had two serious incidents despite having really formal processes. It's not the process, it is something coming in from the side. Not the stuff we do, but the stuff that new and coming in. We have a page of A4 to go to court with and that's not good enough. Would that hold up in court. I don't have the resources to (micro) manage contractors. It's the side swipe that will get you. I'm not sure we are covering all these tasks. I have had to drop the management job to do an operational job as I have no replacement. It's down to resources. There pressure to cut corners and that's where we are exposed. Lack of experience of staff, lack of resources combined with something coming at us that we just can't see.*

B3 - AIRAMP TELEPHONE INTERVIEW NO 3: 14:00 1st MAY 2017	
Answer 1:	*Score: 7*
Answer 2:	*They're pretty much okay. You know, the processes and rules. The bits that concern me is the rule breaking. The fact that they are breaking rules is concerning. I'm hoping they have miss interpreted the question. We need to get the message across to the troops - it is a risk to safety. When SMS (*Safety Management Systems*) first came out everyone was trained but the new guys don't get any training.* *Hopefully we have enough in the SMS process. We have systems like XXX everything is online and everyone has access. Hopefully this will all help. Like I said in the last question. It's all there, it's how we do it day to day now and that's down to how good we are. Things are well enough but not good enough. How well trained we are and how we get the message through to the guys; that our job. There is definitely an issue and we are worried that if something goes wrong higher management are looking for someone to blame.* *There's e-learning but not as good as face to face training. Nothing in the assessment that I particularly disagreed with but... The safety portal is particularly effective. It's easy to use and very accessible and it get actioned now you can see things are being actioned....* *Really need to align senior management attitudes with the guys out on the line. That's the thing. That's it really.*

B4 - AIRAMP TELEPHONE INTERVIEW NO 4: 12:00 17th MAY 2017	
Answer 1:	Score*: 8.*
Answer 2:	*I was very worried. What could happen if something went wrong. Sharing a cell with my managing director was my own worry. I knew there was going to be fall-back on me. This is something shared with other department managers, but not as high as me. They didn't see it as high a risk as me. I'm more a thinker than they are – more of a think ahead type person.* *Things are improving. Things are getting better as people are reporting more and making better observation. I think that senior management have a more responsible attitude for safety culture. In one aspect they are, but in another; those that are not as high as local management, they don't see it the same way; I totally agree with that. There's always that element. We in the fire service know how far to take risk it's what we do every day.* *We are doing a dynamic risk assessment every day and know how far to take it. We are not breaking rules but making it work better. We see safety management in a different way than most other departments. Not all firefighters are like that some are not in agreement with senior management and their attitudes to safety.*

B5 - AIRAMP TELEPHONE INTERVIEW NO 5: 9:00 18th MAY 2017	
Answer 1:	Score*: 8.*
Answer 2:	*Okay, I suppose the result is there in the evidence as it was represented with in the report. When you take a group over five stations you get an average across the different groups. Risk taking is frowned on but to get the job done it's how it happens, it is correct in how its reported in the report. The sharp end… there is always a high risk of injury or failure of equipment. But it's the trivial stuff that gets you. When something bad happens then its more common than those on the job who 'know best how to do the job' get the blame. If something happens then it's a learning opportunity that's what happens in life and in industry. Those giving scoring then, how long have they been in the job? You get very different attitudes depending how long you have been in the job. You should compare stations that have experienced staff and those that have a high turn-over. If they come from a building site or an oil rig it depends on the safety culture they bring into the operation.* *As I was reading the report I think the hardest job is middle management. It's okay to be senior management and introduce new regulation and policy. The middle manager must implement it. How they do that is crucial to safety and people's attitudes. Particularly if it goes wrong.* *Well, the only way you can truthfully answer that is if something bad happens. The man at the top will have a very different attitude to me as a middle manager. Bearing in mind it is their policy. The guys making a mistake haven't done it on purpose. They should be protected.* *A recent example was when a member of staff was injured and ended up taking the company to court. I was then investigated and it ended up in court to test whether the company was discredited. We were not briefed on what would be said by the company we were left alone waiting to be called. What struck me was that someone had to go to justify what happened. I would hope to think we would be better treated in the future. We had more engagement with the claimant's lawyers than with our own companies' lawyer.* *If there is an attitude of high risk taking then that will filter directly down to the crew. The most important job is middle management and their opinion, their culture directly affects the operational culture.*

Appendix G Group Discussion (C)

Written notes were taken during the following discussion of the 27th April 2017 which was then immediately typed up and saved. Clarification on some comments was sought after the conversation to avoid interruption. As this conversation was during a telephone conference, the identity of the speaking party was occasionally difficult to determine. The speaking manager is identified by the order in which they first spoke (e.g. C3 spoke third). All subject comments are recorded in italics question mark is placed where the speaker's identity was uncertain.

Prior to the researcher asking about the d3SC result accuracy, a brief discussion took place to explain and review what the process entailed and how the data would be used.

Interviewer: What is the accuracy of the analysis as a description of Airamp's safety culture?

C1: *I feel there is more understanding between management and the operational staff, but there is a lot workaround still going on.*

C2: *There is a concern that something gets missed. That you don't do something when there is so much to do.*

C?: With less people and time to do it…

C3: *Management and staff are developing better safety culture but as new procedures come in there are more workarounds*.

C1: *The risk process is certainly becoming more structured. Every time there is a new incident, the implications are considered from every angle*.

C2: *I think we are not looking close enough at the actual task itself. We do the risk assessment but we don't then look at what that means – physically. We are not looking at what they actually do. When you give the guys on the line that level of responsibility then that's when you get best practice. It's not just a case of looking at the risk assessment but physically looking at the task in hand.*

C1: *The thing is, mitigations are added but the others are not taken way. They just add them on. In the end, we have a load of mitigations and forget what the original task was and how to make it safe.*

C?: *From about 2010, we have become far more cognisant of risk. In the past risk was discussed but the discussions were not then applied to practice. We knew there were issues but didn't do enough (well sometimes nothing), to deal with it.*

C3: *I don't know whether this is relevant but most of the guys here and those included in the study have a background in firefighting services, we are used to 'dynamic risk'. We arrive in situations where there has been little or no previous risk assessment. We're used to that.*

C2: *There's definitely an increase in concern for some comeback. Even if something isn't written down, there's always that care-thing…* [Researcher: "Duty of Care?"] *Duty of Care, that's it. You must be thinking this stuff every day to keep on top of things.*

C?: Any other comments on that?

C1: *I have conflicting views (that's why I kept quiet). On one hand the company is in a far better place than it was back in 2011 – 2012. Everything goes through SMS [safety management system]. People report and are confident…*

C4: *In the past, it often was perceived to be a bit of a witch-hunt. Not now. Everything gets reported. On the other hand it's the amount of mitigation we try to pile on its just too much, sometimes. You can't mitigate against everything. You can't see everything and you're just going to get side swiped by the unknown.*

C?: *Deviation from SOPs* (standard operating procedures) *is an issue. It may be the case that some rules are okay to break but others, never. The thing is, with so much mitigation, it is harder to work out what is important and maybe we need to look at that.*

C2: We need a lot of SOPs because that's the business we're in.

C5: *Yes but it's how the guys go about their work that's important. We don't need to be so prescriptive; that's our business…*

Appendix H Raw Data From the Airamp 3 Survey

AIRAMP 1

Ques No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
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16	1	2	4	4	1	4	1	4	3	3	4	2	2	2	3	4	5	4	3	1	1	1	4	4	4	2	4	5	2	4	5	2	3	3	1	1	5	3	1	1	2	1	3	5	3	1	1	2	5	1

AIRAMP 2

Ques No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
17	2	4	5	5	1	5	1	2	1	1	4	3	1	1	1	4	4	5	2	2	1	2	1	5	4	4	4	5	4	5	4	1	4	4	2	1	5	1	4	1	1	2	3	5	4	1	3	5	5	1
18	4	5	5	3	4	1	1	3	1	4	4	4	1	4	1	5	5	3	3	4	1	2	2	5	4	4	5	5	2	4	4	2	4	4	2	1	5	2	3	1	2	5	4	5	5	1	3	3	4	1
19	2	4	4	5	1	5	1	3	2	2	4	4	3	2	2	4	4	4	4	3	2	2	3	4	4	4	4	4	3	4	4	2	4	3	2	2	5	2	3	2	2	2	3	4	4	2	2	4	2	2
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23	5	4	3	4	3	4	1	3	1	1	5	3	5	1	1	4	4	5	2	4	1	1	4	4	3	4	5	5	3	5	1	2	3	4	1	3	5	2	1	1	1	1	5	5	4	1	2	1	5	1
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25	2	4	4	4	1	2	2	2	2	2	4	4	1	3	2	4	4	4	3	3	1	4	2	4	3	3	4	4	2	4	1	3	3	4	2	2	4	2	3	2	2	2	3	5	4	2	3	2	4	1

AIRAMP 3

Ques No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
26	2	3	4	4	1	4	1	5	3	1	4	3	1	1	3	4	4	2	3	1	1	4	3	4	4	4	4	4	2	4	4	2	4	4	1	1	4	1	1	1	2	2	4	4	4	1	1	5	5	3
27	4	2	2	1	5	2	4	2	1	2	2	2	5	3	4	1	1	5	3	3	2	4	3	2	2	2	2	3	5	2	3	4	1	1	4	4	2	3	2	4	3	4	2	2	2	3	3	3	1	5
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29	3	4	4	5	1	4	1	4	3	2	4	4	2	1	3	4	4	3	1	3	1	2	2	5	4	4	3	4	2	3	1	1	1	5	1	1	5	1	1	1	2	3	4	4	3	1	2	5	3	2
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32	2	4	2	4	2	5	2	4	1	2	4	4	1	3	1	4	4	3	3	2	1	1	5	4	3	3	4	4	3	4	3	2	3	3	2	2	4	3	2	2	2	2	3	5	4	2	3	3	3	3
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45	1	4	3	3	2	5	1	4	1	1	5	4	1	3	3	5	3	4	2	1	5	2	2	3	4	3	5	5	2	3	3	1	4	4	2	2	1	2	2	3	2	2	3	3	2	2	2	3	5	2
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55	2	5	5	4	4	4	1	4	2	2	4	4	2	3	4	4	3	4	2	3	2	2	3	2	3	3	4	4	4	4	4	2	4	4	2	2	4	3	4	4	4	2	2	3	4	4	2	2	4	4
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61	3	5	2	5	1	5	1	5	1	2	5	3	3	2	4	4	5	4	1	1	1	3	4	4	4	4	5	5	3	4	1	1	4	4	1	5	2	1	1	1	2	1	4	5	4	1	1	1	5	3
62	1	5	3	4	2	5	2	4	2	2	4	4	2	3	5	4	3	2	4	2	2	5	5	4	4	3	4	4	4	3	4	3	2	4	4	4	2	4	3	3	2	2	2	3	4	4	2	2	2	4	2
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65	1	5	5	5	1	5	1	4	1	1	5	5	1	1	3	5	5	3	2	3	1	3	3	3	3	3	5	5	1	4	1	1	3	5	1	1	4	3	2	1	1	1	5	5	5	1	3	3	3	1
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68	1	4	4	5	3	5	2	5	1	1	5	5	1	1	1	5	4	5	1	1	1	1	4	4	4	5	5	2	4	4	1	5	4	1	1	5	2	2	1	2	1	5	4	1	2	5	5	3		
69	3	3	2	3	4	4	1	3	4	3	3	3	4	4	4	4	2	4	3	4	3	4	4	3	3	3	4	3	4	4	3	3	2	3	3	3	3	5	4	4	3	1	3	3	3	3	3	3	4	3