Safety culture and safety climate: A review of the literature

Steven Yule
Industrial Psychology Research Centre, University of Aberdeen, UK

Please cite as:

Yule, S. (2003). *Senior Management Influence on safety performance in the UK and US energy sectors*. Doctoral thesis, University of Aberdeen, Scotland.

Correspondence to:
Steven Yule, Industrial Psychology Research Centre, University of Aberdeen, King's College, Old Aberdeen AB24 2UB, Scotland, UK
Email s.j.yule@abdn.ac.uk
Tel: +44 1224 273214
Fax: +44 1224 273211

Introduction

Effective safety management in the twenty-first century involves paying attention to human factors as system components with as much potential to cause, or save, dangerous system states as technical components. By paying attention to human factors, highly reliable organizations can identify and capture potential hazards before they manifest as accidents. One method of achieving this is by measuring the state of safety through so-called 'leading' indicators such as safety culture or safety climate. These are seen as distinct from 'lagging' indicators of safety such as accidents as they offer insight into the state of safety without the need for retrospective analyses of negative safety outcomes.

Empirical research on safety climate has developed considerably since Zohar's seminal (1980) study in Israeli manufacturing. However, the theoretical development of safety climate and safety culture has not mirrored that progression. Despite a general agreement among researchers, regulatory bodies, and industry that these concepts are worthwhile concepts for research and application, little consensus has been reached over other important issues. For example, there are multiple definitions of the two concepts; safety climate and safety culture are often confused in the literature despite having distinct etymology (Cox & Flin, 1998); no clear model demonstrating the impact of safety climate and safety culture on bottom-line safety organizational performance has been developed; numerous methods covering different sets of factors have been used to measure the concepts, and many of the studies that have been reported suffer from methodological failings. Guldenmund (2000) summarises the current state of the art by arguing that most efforts have been focused on the face validity of safety climate measures, rather than tackling the issues of construct or predictive validity that would advance the research field beyond its first stages of development.

This literature review treats safety climate as distinct from safety culture, despite the confusion surrounding the two concepts in the literature. The aims of this literature review are fourfold:

i. Differentially define safety culture and safety climate
ii. Outline the origins and conceptual development of safety culture and safety climate
iii. Examine methods of measuring safety culture and safety climate
iv. Discuss the published results of empirical studies on safety culture and safety climate

The review is split into three main sections. Section 2.2 considers theoretical issues regarding safety culture and safety climate. Section 2.3 discusses the research findings on safety culture, and section 2.4 discusses the results of empirical studies of safety climate. Table 2.1 outlines these studies and is presented at the end of the chapter.

Theoretical issues

Defining safety culture

The term safety culture gained its first official use in an initial report into the Chernobyl accident (IAEA, 1986). This report introduced the concept to explain the organizational errors and operator violations that laid the conditions for disaster. Public Inquiry reports have since implicated poor safety culture within operating companies as a determinant of several high-profile accidents since, such as the explosion on the Piper-Alpha oil platform in the North Sea (Cullen, 1990); the fire at King's Cross underground station (Fennell, 1988); the sinking of the Herald of Free Enterprise passenger ferry (Sheen, 1987), and the passenger train crash at Clapham Junction (Hidden, 1989). The relevance of safety culture to safe operation is not disputed (Cox & Flin, 1998). Indeed, Reason (1998) argues that it is a concept 'whose time has come' (p. 293). However, there is no definitive definition of the concept for two main reasons: (i) different researchers emphasise different elements of safety culture as most salient, and (ii) culture of any kind is an extremely difficult concept to succinctly define. Reason (1997) makes the case that for engineers, defining organizational culture has '...the definitional precision of a cloud' (p. 192). The same argument may also be levelled at defining safety culture (Pidgeon, 1991). A number of definitions of safety culture are offered in the literature. For a comprehensive analysis of 18 of these definitions (including definitions of safety climate, considered in the following section), see Guldenmund (2000, p. 228). Two of the dominant definitions are as follows. With reference to the Chernobyl disaster, the International Atomic Energy Agency (IAEA) defined safety culture as '…assembly of characteristics and attitudes in organizations and individuals which established that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance' (IAEA, 1991; p. 1). The UK Health and Safety Commission (HSC) endorse this position and provide a number of characteristics that are expected in positive safety cultures by defining the concept as '… the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's health and safety management. Organizations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventative measure.' (HSC, 1993; p. 23).

Most definitions of safety culture encapsulate beliefs, values, and attitudes that are shared by a group. As human behaviours (and thus at an individual level, safe or unsafe behaviours) are partly guided by personal beliefs, values, and attitudes (Fazio, 1986; Kleinke, 1984), continued workplace safety may have its base in individually, and organizationally constructed shared beliefs that safety is important. A related theme evident in the definitions of safety culture offered is that of individual norms. Ostrom, Wilhelmsen and Kaplan (1993) argue that a culture is comprised of social norms, which are unspoken rules of behaviour that, if not followed, result in sanctions. An example of a positive safety norm may be that the workforce reports all procedural irregularities. Reason (1997) argues that this norm will only develop under the conditions he calls a 'reporting culture' – a culture in which workers feel free to report their errors and near misses to management without unjust punishment. An example of a less positive safety norm may be that work is conducted on live equipment when under time pressure, i.e. without isolating equipment. Understanding the safety culture of an organization, work site or work-group as a whole may be difficult but identifying and understanding the dominant safety norms may be a more manageable method of attending to specific issues.

Defining safety climate

Zohar (1980) coined the term safety climate in an empirical investigation of safety attitudes in Israeli manufacturing, and defined it as '…a summary of molar perceptions that employees share about their work environments' (p. 96). More recent definitions echo this, for example, Niskanen (1994b) defines safety climate as '…a set of attributes that can be perceived about particular work organizations and which may be induced by the policies and practices that organizations impose upon their workers.' (p. 241). Additionally, Cabrera, Isla and Vilela (1997) conceptualise safety climate as organizational members' shared perceptions about their work environments and organizational safety policies.

Therefore, the definitions of safety climate are clearly related to those of safety culture. For example, Guldenmund (2000) points out that shared aspects are stressed in both sets of definitions. The main differences in the definitions are that whereas safety culture is characterised by shared underlying beliefs, values, and attitudes towards work and the organization in general, safety climate appears to be closer to operations, and is characterised by day-to-day perceptions towards the working environment, working practices, organizational policies, and management. Thus, safety culture and safety climate appear to operate on different levels and this reflects the origin of the concepts in the organizational psychology literature of the 1980's and earlier social and behavioural psychology. As many of the definitions of safety culture and safety climate have common elements, safety climate may reflect the underlying culture of the work-group or organization, although its focus is actually much narrower than safety culture. More specifically, safety culture is seen as a sub-facet of organizational culture (Cooper, 2000) and exists at a higher level of abstraction than safety climate (Reichers & Schneider, 1990). It seems plausible that safety culture and safety climate are not reflective of a unitary concept, rather, they are complementary independent concepts.

Origins of safety culture and safety climate

The concept of safety culture has its origin in the social and behavioural psychology of the 1950's and 1960's that came to the fore in the organizational psychology, organizational behaviour, and management literature of the 1980's. This literature offers a number of definitions of organizational cultures and climates that clearly resonate with those presented on safety cultures and climates above. For example, Uttal (1983) defines organizational culture as 'Shared values (what is important) and beliefs (how things work) that interact with an organization's structures and control systems to produce behavioral norms (the way we do things around here)' (p. 67). This definition appears to be so relevant to the current topic that Reason (1998) wrongly cites this as a definition of safety culture rather than organizational culture.

Culture is learned through the process of socialisation which may be one of the reasons why culture change is a long and difficult process. Formal training will reflect a flavour of the underlying culture but much of the information needed by the individual to understand and become part of the culture will be inferred through observation and informal discussions with the workforce. Therefore, the best method of understanding a culture may be to be part of that culture. Rochlin, LaPorte & Roberts (1987) confirm this assertion by conducting ethnographic research onboard US aircraft carriers. It may be that the only way to fully understand an organization is to be part of it, however, most researchers have to be content with interacting with individuals who are part of the culture in order to get a grasp of its nature. This highlights a completely new issue, as touched on by Ostrom et al. (1993). If aspects of culture are symbolic, unspoken, and unwritten, how can they be analysed and understood by those who are not part of the culture? In addition, if only those embroiled in a particular culture can understand it, how are they able to communicate the features of the culture with others who are not part of it?

There is also some debate, initiated by Hofstede (1980), and revived by Reason (1998), about the ownership of culture. Some theorists argue that the organization has culture, whereas others argue that the organization is culture. Like organizational culture, safety culture is assumed to be a relatively stable construct, similar to personality, and resilient to change in the face of immediate and transient issues.

The concept of work climate in the literature actually predates culture by about 40 years. Lewin, Lippitt, and White (1939) made the earliest explicit reference to climate in an organizational setting in a study of the effect of leadership on the ‘social climate’ in groups of boys, although they did not define the concept. Definitions of organizational climate reflect those presented of safety climate earlier. Another early recognition of the impact on managers on climate was by McGregor (1960) who recognised the importance of daily role-modelling behaviours of supervisors and managers in setting the climate. Coyle, Sleeman, and Adams (1995) latterly define organizational climate as employee perceptions of ‘the social and organizational circumstances in which employees work’ (p. 248), emphasising that climate is a phenomenon that can change daily and be influenced by circumstance. Climate influences what work is done, how work is done, and by whom work is done. Climate may operate at the level of individuals and small cohesive groups. Schneider (1975) argues that each individual’s perception of the climate will differ because workers have different tasks, supervisors, peers and positions in the organizational hierarchy. Changes that affect the way they work such as a new supervisor or what they do such as promotion or redundancy will affect their perception of climate. Likewise, events that transcend across a whole site or organization such as widespread redundancies will affect more individuals and be reflected by widespread climate change. Safety climate describes the atmosphere of the state of safety in an organization. It is best perceived as a subset of organizational climate (Coyle et al., 1995) and Williamson et al. (1997) argue that safety climate represents the safety ethic in an organization and is one contributor to the overall organizational culture.

Cox and Flin (1998) report that the theoretical and empirical development of research on organizational culture and climate has progressed differently. Organizational culture research has been more concerned with definition and theoretical underpinnings; measurement has been qualitative in nature, through use of observation and interviews, and the results of these have been linked less with organizational outcomes such as productivity, efficiency, and satisfaction, in preference for in-depth case studies. In contrast, organizational climate research has valued empirical research of the concept over theoretical development. Climate has predominantly been measured by qualitative methods such as questionnaires, and analyses have linked a positive organizational climate with several outcome measures, including increased production (e.g. Pritchard & Karasick, 1973), and greater job satisfaction (e.g. Schneider, 1975).

Conceptual development of safety culture and safety climate

The theoretical and empirical development of safety culture and climate has followed the pattern set by organizational culture and climate, although to a lesser extent. As stated previously, most efforts have focused on the empirical issues surrounding safety climate although it is possible to identify theoretical development of concepts within the safety culture literature. Also, the terms safety culture and safety climate have been used interchangeably in the literature (Cox & Flin, 1998). Denison (1996) states that the research methods used by researchers can aid distinction between studies that have measured safety culture from those that have measured safety climate. He states that measuring culture requires qualitative methods whereas climate can be measured by quantitative methods and goes on to argue that quantitative measures such as questionnaire surveys cannot fully represent the underlying safety culture. These surveys offer a snapshot of the prevailing state of safety and are useful in determining employee perceptions about safety in their organization at a particular moment in time. In concurrence, Schneider (1990) argues that climate can only give a flavour and indication of the underlying culture, and cannot capture the ‘full richness’ of the organizational culture. Cox and Cox (1996) also demonstrate this point by likening culture to personality, and climate to mood. Conducting a survey will assess the current mood state of an individual. Some responses may be indicative of the individual’s stable underlying beliefs, constructs and personality but overall, the survey will reflect how the individual feels at that point in time. The comparison between culture and personality seems attractive because personality is relatively stable over time whereas climate and mood can be susceptible to short-term fluctuations (Pervin, 2003).

In addition to this, as the concepts of safety climate and safety culture were developed from their longer-standing organizational counterparts, the theoretical development of these concepts indicates that they should be conceptually distinct. Considering the research field of safety climate and safety culture as a whole does not reflect this. The distinctions between definitions of safety culture and safety climate made earlier leads to the conclusion that the vast majority of research on safety culture actually reflects safety climate instead. There are notable exceptions to this rule, as the literature offers a handful of well-developed quantitative measures that were developed using qualitative analyses of safety culture, and are designed to measure cultural artefacts such as beliefs, values, and norms, alongside perceptions of safety climate (e.g. Carroll, 1998; Lee, 1998; Ostrom et al., 1993).

Theoretical development of safety culture

Building on the organizational culture literature, Reason (1997) identified five important components of safety culture as follows: (i) informed culture, (ii) reporting culture, (iii) just culture, (iv) flexible culture, (v) learning culture. An informed culture is a safety system that collates data from accidents and near misses and combines them with information from proactive measures such as safety audits and climate surveys. In many ways, an informed culture is a safety culture. In turn, this safety system requires the active and honest participation from the workforce to report near misses, complete attitude surveys and become involved in how safety is managed in their organization. This is called a reporting culture, characterised by an organizational climate in which workers feel free to contribute to the informed culture. However, workers will not feel free to contribute unless a just culture, characterised as an atmosphere of trust, is in evidence. This must be distinguished from a no-blame culture, as a just culture does not turn a blind eye to criminal or negligible acts. In some instances, rewards may be offered for reporting near misses in much the same way as they are for safe behaviour although there are potential problems with this such as over-reporting. Collecting this information is futile unless it is used to enhance the safety performance of the organization. A learning culture is needed to draw appropriate conclusions from the information collected along with the will to implement changes to procedures and equipment as deemed necessary. These components are similar to those cited by Weick (1987) whose criteria for high reliability in an organization is a culture that encourages interpretation, improvisation, unique action, and a climate of trust and openness between management and worker. The results of safety culture studies presented in section 2.3 also show the theoretical underpinnings of the concept through case studies of high reliability, comparisons of high and low performing organizations, and organizations in crisis.

Empirical development of safety climate

It is generally accepted that safety climate is a ‘snapshot’ of workforce perceptions of safety (e.g. Mearns, Flin, Fleming, & Gordon, 1997). Quantitative methods, especially cross-sectional questionnaires, have commonly been used to measure these perceptions (Denison, 1996). This method facilitates asking large numbers of people their opinions in a relatively time- and cost-effective manner (Oppenheim, 1992).

Although the concepts of work and social climate have appeared in management and psychology literature for over 60 years, measuring safety climate is a relatively recent technique. Attitudes towards the organization were measured before this and continue as part of assessing the organizational culture but were rarely specifically safety-focused until Zohar’s (1980) seminal study. Since then several research teams have developed their own methods of assessing safety climate. This has led to a number of differing methods, each offering a way of collecting sensitive information about employee attitudes and perceptions regarding a wide range of safety-related issues at their place of work. Almost without question, the construction of such methods has been done in conjunction with a particular organization with a view to measuring safety climate at specific sites with no great crossover of use to other sites, organizations, or domains once the measures have been developed. This has led to a proliferation of instruments that, with one or two exceptions, are specific to an organization, or at best, to the industrial sector for which they were developed. Two notable exceptions include the Offshore Safety Questionnaire (OSQ), developed by Flin, Mearns, Gordon and Fleming (1996) on the basis of earlier work by Marek, Tangenes, and Hellesoy (1985), and Rundmo (1994). The OSQ has been used in several offshore environments, as well as in healthcare, mining, and forestry settings around the world. The second exception is the UK regulator’s Health and Safety Climate survey tool (HSE, 1997b), which was developed to be used across all UK industrial sectors. The relative merits of this instrument will be discussed in detail in the following chapter. In general, the only continual development of safety climate instruments has been to refine the question sets in order to improve face validity, and in some cases to conduct factor analyses and internal consistency checks. These have been favoured above examinations of construct and predictive validity (Guldenmund, 2000), without which the research field is unable to progress beyond its first stage of development. As a result, there is a danger of the concept outstripping evidence for its utility (Cox & Flin, 1998).

A number of qualitative methods have been used to develop quantitative measures of safety culture and climate. These include interviews, focus groups and brainstorming sessions. Ostrom et al. (1993) used interviews with a number of personnel at a US nuclear power plant, ranging from labourers to management. Respondents were asked three questions to ascertain what people would be doing in three years time if the company became a world leader (i.e. desired future norms), how far personnel would have to go to reach that level of performance (i.e. comparison between present and desired norms), and what happens currently (i.e. current norms). Safety questionnaire items were based on content analysis of those responses and focus groups with managers. Carroll (1998) also used open-ended questions that were designed to elicit current norms and desired goals. Workers were asked to identify a recent incident that showed the strength or weakness of the current safety climate and what changes they would instigate were they vice president, in a study in the US nuclear power industry. These questions may be more reflective of safety culture than other safety climate questions.

Focus groups were also key strategies employed by Lee (1998) in the development of a 172-item questionnaire used in the UK nuclear power industry; Carroll (1998) in the US nuclear industry; Mearns et al. (1997) and Mearns, Flin, Fleming and Gordon (1998) in the UK offshore oil and gas industry, and Cox and Cheyne (2000) also in the UK offshore industry. However, whereas Carroll (1998) interviewed managers, supervisors and the workforce separately to avoid hierarchy issues and promote openness, Lee (1998) reported no hierarchy problems with mixed groups. Finally, a novel construct generation technique is reported by Coyle et al. (1995). They asked industrial personnel to generate the six most important health and safety issues to them and these were arranged in a hierarchy of importance during a brainstorming session. This formed the basis of a questionnaire.

Safety sub-cultures and sub-climates

Safety culture has been hypothesised to operate on a number of organizational levels. In addition to the global safety culture of the organization, unique cultures can exist at individual work-sites, and for individual departments or work-groups. Large organizations that have multiple sites worldwide are likely to have several organizational cultures, based on geographic locations of their business. In fact, it may not be beneficial to speak of one organizational culture. Certainly, core values such as a commitment to safety will be evident in all the cultures but local influences such as managerial style and national culture will tailor the culture of a particular site or group of employees. Schein (1992) defines the culture of the group as ‘A pattern of shared basic assumptions that the group learned as it solved its problems of external adaption and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems’ (p. 182).

The idea of group culture rather than a single organizational culture allows for the existence of several group cultures at different stages within a single organization. The individuals who come together to form functional groupings will have different beliefs, values, and expectations, and will also bring different experiences from past employers and previous work-groups. As culture is determined by shared beliefs and values, it is likely that different workgroups will have different safety cultures as a function of the individual members of the groups. Therefore, despite the fact that the same safety-related issues will be prevalent across work-groups at the same site, across sites and across organizations, no two sub-cultures will be alike. Cooper (2000) argues that that sub-cultures will be either in alignment or at odds with the dominant ‘cultural theme’ of the organization. This casts doubt over the notion that organizational safety culture is composed of shared behaviours, beliefs, attitudes, and values (Williams, Dobson & Walters, 1989) as the degree to which elements of culture are shared may be diminished from lowest to highest-level of subculture (i.e. elements of culture may be highly shared within a stable work-team but the degree to which they are shared across all the work-teams at one site may be considerably less). Mearns et al. (1998) confirm the presence of fragmented ‘safety subcultures’ in a UK offshore sample, which varied as a function of seniority and prior accident involvement. They suggested that the interaction of different subcultures on one work-site partly determines the prevailing safety climate of that site. Identifying the diversity of perspectives on safety issues reflected by the differences between sub-cultures can also be useful for dealing with collective ignorance determined by systemic uncertainty (Pidgeon, 1998), and for encouraging debate over the solutions to long-term safety issues.

Measuring safety culture

It is important to note that conceptual differentiation between safety culture and safety climate dictates that measuring safety culture and safety climate require different methods. A number of qualitative methods have been used to measure safety culture, including interviews, focus groups, audits, and expert ratings. Studies that have measured safety culture have generally used a case study format to report findings. Thus, there are case studies of high reliability organizations, comparisons of high and low accident plants, and narratives of organizational crises. Studies that have measured safety culture have generally rejected quantitative methods such as questionnaires as an inappropriate means of data collection. However, a number of studies have used qualitative methods to investigate safety culture, and then developed quantitative methods on the basis of those results (e.g. Lee, 1998; see section 2.2.4.2).

As mentioned above, Carroll (1998) used qualitative methods such as interviews and focus groups to investigate safety culture in the US nuclear industry and argues that the results of questionnaires are open to misinterpretation and researcher-bias unless some form of follow up is conducted with respondents. He found that involvement, accountability, and the role of supervisors were the most salient issues in a safety culture assessment of a US nuclear plant. It was also found that managers received ambiguous cues from questionnaire data and were subsequently tempted to take quick action in response, the so-called 'quick fix', with little regard for long-term solutions. Weick (1995) argues that without benchmarks, safety climate measures are inherently equivocal if used to direct policy in this manner. Clarke (1999) also used a series of interviews to measure safety culture in the UK railway industry, in order to create a novel quantitative measure to assess safety culture. This measure allowed employees to respond to questions about safety culture from the viewpoint of different organizational levels as a means of assessing shared perceptions of culture. Interviews and focus groups are often also used in the development of safety climate questionnaires. Expert ratings are another method that has been used to measure safety culture. Roberts, Rousseau and La Porte (1994) report a study where experts rated the manifestations of safety culture such as communication of symbolism and beliefs, rites and ceremonials as a way of gaining insight into the safety culture of two US nuclear aircraft carriers. Based on the Organizational Culture Inventory (OCI; Cooke & Lafferty, 1989), focus groups involving officers and other senior on-board personnel guided the direction of the study and the results were combined with those of an employee survey to create a case study of safety within High Reliability Organizations (HROs).

Case studies of High Reliability Organizations (HROs)

The US nuclear aircraft carriers that Roberts et al. (1994) investigated are one set of so-called ‘High Reliability Organizations’ (HROs). HROs perform better than they are expected to given the level of technology employed and levels of risk managed during regular, high-tempo operations (Weick & Roberts, 1993; Weick, 1995; Weick & Sutcliffe, 2001). They emphasise shared values that characterise safety culture and differ from other organizations by focusing on process reliability above product reliability, and by maintaining this high level of process reliability for long periods of time. Often the nature of their business means that they cannot slow performance under the threat of danger. In such a situation, the danger must be diffused while performance is maintained. HROs have been found to perform at high levels of safety, reliability, and system integrity apparently as a result of strong cultural values that are shared by workers and management. However, the studies on HROs do not report the cause and effect data that would be required to ascertain this relationship.

HROs have great importance with respect to safety culture and research on HROs makes a strong case for safety culture as a facet of organizational culture by synthesising the findings of the research on HROs to one global construct called ‘mindfulness’ (Weick & Roberts, 1993; Weick & Sutcliffe, 2001). Mindfulness is a state of constant awareness within high-hazard environments that is always looking for failure, managing safety while maintaining high-tempo operations, and empowering sharp-end operators with commensurate experience to make critical decisions. Much of the success and failure of organizations to manage highly complex technology is attributed to the extent to which management genuinely advocate mindfulness in operations (Weick & Sutcliffe, 2001).

Comparative studies

Comparative studies have focused on the characteristics of ‘safe’ (i.e. low accident) versus ‘unsafe’ (i.e. high accident) worksites and departments. One such study was conducted by Cheyne and Cox (1995) with 13 European manufacturing plants from the same organization. They concluded that plants with low accident frequencies had employees with more positive attitudes to safety, more positive appraisals of management commitment to safety, higher levels of compliance, and a better-managed hazardous environment. Lee (1998) adds more depth to this finding by stating that the main characteristics of low accident plants are: high frequencies of informal safety communication; evidence of good organizational learning; strong commitment to safety by senior management; democratic and participative leadership styles; safety aspects emphasised in skills training; good housekeeping; high levels of job satisfaction, and safe work as a criteria for recruitment and retention as distinct from productivity. The role of housekeeping (including clean and comfortable working conditions) in low accident frequency confirms the earlier findings from an assembly plant by Keenan, Kerr and Sherman (1951).

Organizations prone to, in, or recovering from, crises

Retrospective analyses of major disasters that have warranted a Public Inquiry report (e.g. the King's Cross fire; Fennell, 1988), Presidential commission (e.g. Challenger; see Vaughan, 1996), or an OSHA Inquiry (e.g. Three Mile Island; Perrow, 1984), have commonly identified poor safety culture as a contributory factor. Commonly cited characteristics of these substandard safety cultures include an absence of senior management commitment, poor housekeeping, lack of organizational learning, and demand for productivity or meeting schedules as a priority over safety of plant and personnel. These factors are in line with the characteristics of low accident plants presented by Lee (1998) so it may be appropriate to conclude that poor safety culture is related to higher probabilities of both individual accidents and organizational-level accidents (i.e. major disasters). This conclusion is intuitively appealing, however, it is mainly retrospective in nature and relies on the identification of factors common to those organizations, which may have no predictive power in determining where or when the next organizational accident may occur (Whitaker & Yule, under review). Having said that, identifying the characteristics of organizations in crisis is important in the drive to avoid future disasters, and many of these characteristics are reflected in safety climate scales (e.g. Flin, Mearns, O'Connor & Bryden, 2000), which highlights synergy between leading and lagging indicators of safety.

Measuring safety climate

The multiple definitions of safety climate in the literature (e.g. Flin et al., 2000, Guldenmund, 2000) has determined to a large extent what variables research teams have incorporated when developing measures of safety climate. The central debate among theorists appears to be whether safety climate should be restricted to workforce perceptions about management and the manner in which management reconcile safety with productivity (Brown & Holmes, 1986; Dedobeleer & Beland, 1991; Zohar, 1980, 2000), or whether the role of management is incorporated with other safety issues such as risk perception, worker involvement, personal accountability, perceptions of the physical environment, and job communication (Cox & Cox, 1991; Williamson et al.,1997; Cox et al., 1998; Cheyne, Cox, Oliver & Tomas, 1998; Lee, 1998; Mearns et al., 1998, 2001). This debate has not been resolved, and as a result the research field of safety climate has favoured empirical research over theoretical development.

The purpose of this section is to review the safety climate literature, paying particular attention to the results of studies that have identified influences on, and the influences of safety climate. In total, 31 studies were identified in the literature and are reviewed in this section. They are summarised in table 2.1 which is presented at the end of the chapter. The majority of these studies were conducted in high hazard industrial sectors, including transport, power generation, offshore oil and gas production, manufacturing, and construction. The results are presented thematically, under the headings managerial factors, supervisory factors, workforce factors, and other system factors.

Managerial factors

This category is used to refer to all factors that non-supervisory management can directly influence. These include organizational policies, systems and procedures, management and leadership style, and management commitment to safety. A recent review of safety climate studies, and thematic analysis of safety climate factors by Flin et al. (2000) found that 72% of the studies assessed the role of management. Management was also identified as one of only two factors (the other being workforce involvement) that were properly replicated across studies (Dedobbeleer & Beland, 1998). A third review of safety climate themes included a number of studies not covered in the two reviews above, and found that management was the most frequently measured dimension (Guldenmund, 2000). That management is a well-measured component of safety climate is therefore not disputed. Close inspection of the studies in table 2.1 reveals that managerial factors also display a degree of association with safety outcomes.

The seminal study by Zohar (1980) identified two climate dimensions as being most influential in determining safety climate level. The second of these (after relevance of safety to job behaviour) was workforce perceptions of management attitudes to safety. Zohar argued that management commitment was a prerequisite of successful initiatives aimed at improving the state of safety in industrial organizations. This argument has found considerable empirical support. From a study of workers in UK chemical plants, Donald and Canter (1994) found that a number of safety climate scales correlated with self-reported accident involvement, including management commitment. Further evidence for this was provided by Diaz and Cabrera (1997), who report that safety climate differentiated organizations with differing levels of safety in a sample of Spanish airport workers. Workforce perceptions of company safety policy (including management commitment) were deemed to be the most important factor, with perceptions of the organizational philosophy regarding the relative priorities of productivity versus safety, second. Management commitment to safety had actually been studied before the term 'safety climate' was coined. Smith, Cohen, Cohen and Cleveland (1978) found that workforce perceptions of management commitment to safety were related to low accident rates in a cross-section of 42 US industrial plants. Active involvement of management was considered an important determinant of high commitment.

Other studies do not show these effects. For example, Mearns et al. (1998) found no difference in workforce attitudes to the OIM (Offshore Installation Manager, i.e. the site manager) between workers who had and had not suffered an accident. In the same industry, management commitment was a factor that explained the highest variance in safety climate scores but did not discriminate between groups who had and had not suffered an accident (Alexander et al., 1995). In this study no other climate dimension could discriminate between the two accident groups.

Whilst it may be preferable for safety climate dimensions, especially those relating to management, to have some discriminatory power regarding safety outcomes, mixed results regarding self-reported injuries (a lagging indicator of safety) does not necessarily mean that managerial factors are not important to safety climate. More consistent results have been found using other outcomes. For example, Rundmo (1994) found that management commitment to safety was the most important determinant of workforce satisfaction with safety, and with safety-related contingency measures. Organizational support provided by management was the second most important determinant. Cheyne, Tomas, Cox and Oliver (1999) also found that management influenced workforce appraisals of commitment across three UK industries: manufacturing, dairy produce and transport. Management also consistently influenced training across all three samples but only influenced workforce personal actions & responsibility in the manufacturing and dairy produce samples. As well as providing insight into the role of management in workplace safety, Cheyne at al (1999) also argue that the architecture of attitudes to safety are, in part, dependent on the industrial context in which those attitudes are measured. The applied use of such associations is underlined by a study in Australian healthcare. Coyle et al. (1995) argue that modifying the attitudes of management and workforce toward health and safety should improve the organization's safety climate and ultimately their safety record.

Supervisory factors

A model that integrates the safety influences of managers is offered by Thompson, Hilton and Witt (1998), who tested a model based around two central pathways; (i) from 'organizational politics' to 'manager support for safety' to 'safety conditions'; (ii) from 'supervisor fairness' to 'supervisor support for safety' to 'safety compliance'. Management support for safety was also found to positively influence supervisor support for safety. Thompson et al. (1998) concluded that management have an influence on safety conditions but workforce compliance with safety rules and regulations under those conditions is influenced by the perceived fairness of the supervisor.

Supervisors have been shown to have other important influences regarding safety climate. From three Spanish samples of 'high risk organizations', Tomas, Melia and Oliver (1999) found that supervisors played an important role in the accident prevention process by transferring the elements of safety climate to members of the workforce. Evidence for this came from support for a tested model in which the causal chain ran from 'safety climate' to 'supervisor response' to 'co-worker response' to 'worker attitude', and then to 'safety behaviour', 'risk' and finally 'accidents'. Finally, from a study in the US steel industry, Brown, Willis, and Prussia (2000) found that safety climate was negatively related to supervisory pressure, indicating that positive safety climate is characterised by a low-pressure working environment.

Workforce factors

Cheyne, et al. (1998) found that the individual responsibility of workforce members played an important role in the success of safety management influence on safety activities. In this multi-sample analysis of workforce perceptions within a multinational manufacturing company, mediating factors included personal involvement, communication and hazards. Cheyne et al. (1999) investigated the role of workers' personal responsibility further in a study of multiple organizations and concluded that personal responsibility for safety is complementary to, and not a replacement of, good safety training.

In an attempt to shift focus back to group perceptions of safety climate rather than analyses conducted at the individual level, Zohar (2000) found support the hypothesis that safety climate is a group-level construct. He found that group perceptions of supervisor action and supervisor expectation were significant predictors of minor injuries within workgroups for up to five months after the perceptions were collected.

Non-human system factors

Confirmation that the roots of safety climate are in organizational climate was found by Neal, Griffin, and Hart (2000). They found that organizational climate had a higher-order influence on safety climate which influenced safety compliance and safety participation indirectly through the determinants of safety knowledge and safety motivation. Moving on to structural influences on safety climate, Cheyne et al. (1998) found that management influenced safety activities directly, through their influence on the physical work environment in a structural model of workforce perceptions in an international manufacturing company. This was a relatively weak but significant pathway in the model. Another study that treats safety climate as a reflection of system factors is presented by Griffin and Neal (2000) in a study of Australian mining manufacturing. They treated safety climate as a higher-order factor, defined by workforce perceptions of workplace systems. Safety climate was found to reflect management values, safety communication, safety practices, safety training, and safety equipment. Safety climate was found to influence workforce compliance and participation indirectly through a strong relationship with safety knowledge, and through weaker (but significant) relationships with compliance motivation and participant motivation.

Discussion

Theoretical considerations

Safety culture is a set of values and beliefs that guide action, internalised through socialisation and learnt through symbolism whereas safety climate reflects the mood and current attitude toward safety, combined with the dominant underlying beliefs about safety that are measurable. Culture is stable and abiding whereas climate is subject to fluctuation in response to change in local variables. The reasoning behind this distinction lies in the differing development of organizational culture and climate. Culture has been subject to intense theoretical debate whereas climate has been the subject of empirical measurement and analysis. Applied psychologists such as Litwin and Stringer (1968), started to evaluate the concept of climate in the late 1960's without devoting much time to definition. Conversely, the development of 'culture' has been dogged by attempts to produce a universally accepted definition at the expense of empirical definition of the construct (Schneider, 1990).

Safety climate has gained popularity as a result of its applied use and ease of measurement. However, this popularity masks a lack of empirical integrity and conceptual validity, which limits the interpretation of safety climate surveys as domain-specific, cross-sectional surveys that may reflect the underlying safety culture to a certain degree, but cannot fully represent it. The lack of replicated studies and standardized tools for measuring safety climate weakens the ability to generalise research findings from domain to domain and allows the influence of situational and contextual factors to replace sound theoretical underpinnings in determining what factors are measured as safety climate.

Cooper (2000) makes a useful contribution to the debate surrounding the relationship between safety culture and safety climate by arguing that safety culture is thought to affect members' attitudes and behaviour in relation to the organization's ongoing health and safety performance. As safety climate is accepted to be a reflection of those safety attitudes at a given moment in time (e.g. Mearns et al., 1997), it seems fair to conclude that measuring safety climate will pick up elements of the culture to a certain extent. From the above discussion of climate and culture, it is also possible to argue that they are independent concepts that are linked insomuch as they influence each other. It is widely accepted that climate is a manifestation of culture (Schein, 1985), and is strongly influenced by it. Espoused climate is partly influenced by the stable underlying beliefs and values held as culture and it seems plausible that culture change (albeit slowly and selectively) is possible through feedback of strong or persistent perceptual changes in the nature of climate (Lee, 1996).

Empirical considerations

Aside from the theoretical considerations outlined above, reviewing the literature on safety climate raises two main empirical issues that merit discussion. These issues concern the replication of factor structures of safety climate and the use of outcome data to validate the emerging factors.

Invariant factor structures. Coyle et al. (1995) report that the factor structure of their safety climate instrument remained invariant across two matched industrial samples from Australian healthcare. It is likely that the two organizations, although similar in many respects differ in how developed their safety climates were. Coyle et al. (1995) argue that this evidence refutes Glennon's (1982) suggestion that nine factors (adapted from Zohar's, 1980 eight factors) form the basis of all safety climates, on the grounds that matched organizations had some common but some different factors that significantly influenced their safety climates. Other analyses (e.g. Yule, O'Connor & Flin, under review) support this, although Brown and Holmes (1986) report the opposite, finding two work sites with congruent factor structures. Brown and Holmes (1986) argue that as the two factor structures are statistically similar, the nature of safety climate can be validly compared between them.

Lack of objective safety performance criteria. Four main categories of safety outcome measures have been used in studies of safety climate: (i) company accident statistics, including analysis of high versus low accident rate plants; (ii) workforce self-reported accident and incident involvement; (iii) workforce self-reported safety behaviours, and (iv) expert ratings of safety performance by regulator, managers, and supervisors. There are merits and drawbacks of each of these measures. Company accident statistics can be affected by random events, inconsistencies in reporting (including under-reporting), and even if reliable, are often unusable due to restriction of variance. On the other hand, self-report measures may also be unreliable due to reporting biases but if collected anonymously, may be more reflective on the true state of safety than the company statistics.

Summary and conclusions

The research field offers a proliferation of over 20 different safety climate measures that have often been designed specifically for a single organizational context. Therefore, the potential for preconceptions about which questions and factors may be important to influence the research field as a whole is clearly evident. Coyle et al. (1995) argue that the early studies of safety climate by Zohar (1980), Glennon (1982) and Brown and Holmes (1986) into safety climate were influenced by the authors' preconceptions of what questions were important. However, this is an argument that can be levelled at any of the studies that have measured safety climate since the inception of the concept some 23 years ago. Coyle et al. (1995) do concede that there is no way of avoiding the judgements of professionals in determining what is important to ask about safety and that it is difficult to wholly objectively create a tool that will measure safety climate or any other concept.

After reviewing the literature, the overwhelming impression it leaves is that safety climate research has been conducted for 20 years with no great consensus regarding the important factors or questions to ask, save that they should be measured by means of a workforce questionnaire. In contrast, the fact that safety culture exists at a higher level of abstraction than safety climate, and is less widely measured lends it almost higher status than climate. This may be because the notion of culture is far more salient to individuals as it reflects personal heritage, what individuals believe in, and may guide many in-role behaviours. Culture seems far more important in determining who we are, and why we behave in certain ways, whereas climate can be seen as more of a reflection of what we are and what we do. Having said that, the utility of safety climate and its ease of measurement make the concept appealing in the absence of reliable methods of measuring culture that do not involve months or years of ethnography. Additionally, the body of research on safety climate has demonstrated that in many cases workforce perceptions of safety climate have been related to safety outcomes. The following chapter describes a study that builds on this review by testing theoretical models of safety climate using data collected from workforce members in the UK energy sector.

Table 2.1 *Safety culture and safety climate studies*

Study	**Industry and sample** (*n*, response rate where available)	**Data Collection**	**Factors**	**Outcome measures and analysis**	**Synopsis of results: main findings, reliability, validation**
Smith et al. (1978)	US 7 pairs of plants: wood and lumber products (*n*=3 pairs)/ metals (*n*=2 pairs)/ manufacturing (*n*=2 pairs)	Site visits: interviews, plant walk-through, observations, documentary analysis, expert ratings	Management: complexity, commitment, involvement, efficiency. Safety: policy, rules, staff. Financial commitment, plant solvency	Outcome measures: Accident vs. non-accident plants Analysis: Percentage comparisons between low and high accident rate plants	Low accident plants had: (i) higher management commitment to the safety program; (ii) more humanistic approach in dealing with employees; (iii) better communication between first-line and middle management; (iv) closer personal relationships between management and workforce; (v) better hazard control. Training, incident investigation, and policy statements showed no difference between low and high accident plants.
Zohar (1980)	Israel 20 factories (*n*=400)	40 item questionnaire, developed from literature review	Safety training, management attitudes, promotion, risk, work pace, safety officer status, social status, safety committee	Outcome measures: No useable safety outcome data Analysis: Exploratory factor analysis, multiple-range test, expert ranking, stepwise discriminant analysis	Emergence of safety climate as an empirical discipline, eight safety climate factors emerged. High agreement between safety inspector rankings and safety climate scores correlated with climate scores (although small *n* of inspectors)
Glennon (1982)	Australia Mining; saw milling; petroleum; engineering, manufacturing (*n*=198 line managers)	68 item questionnaire	Safety and health legislation, corporate attitudes to safety and health, status of safety officer, importance of training, management encouragement, promotion, risk level, safety vs. production targets	No formal analysis	Nine 'climate dimensions' were found, slightly expanding on Zohar's (1980) eight factors. They should be able to be identified in any organization.
Brown and Holmes (1986)	US Production workers in 10 manufacturing companies (*n*=425, of those 200 had suffered an accident in the past year and 225 had not)	Questionnaire: Zohar's (1980) 40 item measure	Safety training, management attitudes, promotion, risk, work pace, safety officer status, social status, safety committee	Outcome measures: Accident vs. non-accident groups Analysis: Confirmatory Factor Analysis (CFA) using LISREL to test Zohar's (1980) 8-factor structure, Exploratory factor analysis to refine solution	3-factor safety climate model: risk, management concern, management action found to be a better fit than Zohar's (1980) 8-factor model. Post-traumatic (i.e. accident) group's perceptions of risk, management concern, and management action were significantly lower than pre-traumatic (i.e. non-accident) group.
Cox and Cox (1991)	Europe: UK, Germany, Belgium, France, Holland Gas company depots (*n*=630)	18 item questionnaire, developed from literature search and discussions with management and safety representatives	Personal scepticism, individual responsibility, safeness of work environment, effectiveness of arrangements for safety, personal immunity	No outcome measures Analysis: Exploratory factor analysis, test-retest paradigm used to check reliability of questionnaire	Based on the factor analysis and framework suggested by Purdham (1984), a theoretical model emphasising the shared aspects of employee attitudes to safety is presented.
Dedobbeleer and Beland (1991)	Canada 9 construction companies (*n*=384, 71%)	Questionnaire designed specifically for the study. Items reflected Brown & Holmes (1986) 3 factor model (which was based on Zohar's (1980) questionnaire) but the same measures were not used	Model 1: Management concerns, management safety activities, employee risk perception Model 2: Management commitment, worker involvement	No outcome measures Analysis: Maximum Likelihood and Weighted Least Squares using LISREL	Attempts to validate previous research (Zohar, 1980; Brown & Holmes, 1986). Brown & Holmes (1986) 3 factor model was upheld with the data but a new 2-factor model provided an even better fit. The 2 factors of management commitment and workers involvement were correlated .61. The questionnaire only comprised nine questions, roughly one question to represent each factor from Zohar's (1980) solution.
Ostrom et al. (1993)	US Nuclear energy laboratory (*n*=4000 administered across 5 departments)	88-item questionnaire, developed from interviews, analysis of manager's safety statements, and literature review	Safety awareness, teamwork, pride and commitment, excellence, honesty, communications, leadership and supervision, innovation, training, customer relations, compliance, safety effectiveness, facilities	Outcome measures: Accident statistics by department (OSHA recordable injuries in 1991) Analysis: Descriptive statistics for individual items, not factors	One department had a higher number of accidents than the others and was found to have more negative attitudes towards the availability and capability of safety personnel but statistical analyses were not conducted beyond descriptives. Suggestions were made for further interpretation of the results but tests such as t-tests, chi-square, and correlations were deemed difficult to interpret and would not be of additional use to management so were not conducted.
Philips et al. (1993)	UK Package production plant (pre: *n*=373, 71.2%; post: *n*=187)	50 item questionnaire, 28 items from Zohar's (1980) scale	Management attitudes, Safety training, promotion, risk, work pace, safety officer status, social status, safety committee	No outcome measures Analysis: exploratory factor analysis	Study attempted to identify Zohar's (1980) safety climate dimensions in a UK sample but those findings were not replicated. Management and supervisory factors were deemed to be two factors rather than one and a reduced number of dimensions were suggested.
Donald and Canter (1994)	UK 10 chemical sites (*n*=701, mean response rate= 53.8%)	167 item questionnaire, developed from literature, and mapping sentences used for question templates	People (self, workmates, supervisor, manager, safety rep.); attitude behaviour (knows about, is satisfied with, carries out); activity (passive, active)	Outcome measures: Self-reported accidents Analysis: Pearson correlations	Strong relationship between safety climate and self-reported accidents, correlation coefficients were in the order of -.45 to -.83, $p < .05$. Only attitudes towards safety reps. did not correlate with self-reported accidents.
Niskanen (1994a)	Finland Road maintenance, Workers and supervisors (*n*=193, 93%)	80-item questionnaire. 60 variables grouped into 10 factors for analysis	Attitudes of supervisors, Attitudes of co-workers Own attitudes Own actions Feedback Knowledge and instructions Manner of instructing Judgements and attentiveness Errors of others Importance of own professional skills	Outcome measures: High accident rate (>7 accidents/100 workers) vs. low accident rate (<7 accidents/100 workers) Analysis: Descriptive and regression analyses	Carelessness, being in a hurry, lack of safety knowledge, and incorrect safety observations were perceived as important determinants of accidents. Safety feedback was predicted by attitudes of supervisors, attitudes of co-workers, and manner of instructing. Own actions, feedback, and safety judgements significantly predicted safety knowledge and instructions.
Niskanen (1994b)	Finland	21/22 item questionnaire	Workers: attitude towards	Outcome measures: High	Factor structures were slightly different between

	Road construction, 85 work places (workers: *n*=1890, supervisors: *n*= 562)	(10 items plus 12 additional for workers and 11 additional for supervisors), developed from literature	safety in the org., changes in work demands, appreciation of the work, safety as part of productive work. <u>Supervisors:</u> changes in job demands, attitudes to safety within the org., value of the work, safety as part of productive work.	accident rate vs. low accident rate <u>Analysis:</u> Descriptive analyses, t-tests, exploratory factor analysis.	supervisors and workers samples. Supervisors in low accident workplaces rate safety inspections better, rate their own importance higher, emphasise safety over cost, and believe that accidents happen by chance less. Workers in low-accident workplaces value their own roles higher, suffer more mental stress, and report increased job responsibility than their counterparts in high accident workplaces.
Rundmo (1994)	Norway 8 offshore oil platforms from 5 oil companies (*n*=915)	Questionnaire, Developed from literature search/ sources of risks from accidents statistics	Safety and contingency factors, commitment and involvement in safety work, social support, attitudes to accident prevention	No additional outcome measures <u>Analysis:</u> Exploratory Factor Analysis, SEM using LISREL	Management and employee commitment and involvement in safety work was the strongest predictor of satisfaction with safety measures. Perceptions of safety vs. production goals and social support were also significant predictors. Strong positive relationship between management commitment and involvement.
Alexander et al. (1995)	UK, On and offshore oil production (*n*=895)	36-item questionnaire (28 items load on factors), developed from literature review	Conflict and control, supportive environment, attributions of blame, Personal appreciation of risk, personal need for safety, overt management commitment	<u>Outcome measures:</u> Self-reported accidents <u>Analysis:</u> ANOVA	Higher perceptions of climate were felt offshore than onshore for personal appreciation of risk, personal need for safety, and overt management commitment. Individuals who had managerial or supervisory responsibility felt that there was a more supportive environment than those who did not. No differences in safety climate perceptions were found between individuals who had and had not suffered an accident.
Coyle et al. (1995)	Australia Clerical and service organizations (total *n*=880), Organization 1: (*n*=340, 56%), Organization 2: (*n*=540, 63%)	30-32 item questionnaire (26 items constant between organizations), developed by interviews and group-work	Maintenance and management, company policy, accountability, training and management attitudes, work environment, policy/ procedures, personal authority	No outcome measures <u>Analysis:</u> Exploratory Factor Analysis, checks for concurrent validity	Safety climate factors were not stable across organizations. The factor structures of organizations 1 and 2 did not match., calling into question Glennon's (1982) assertion that nine factors would be universally identified, and Brown and Holmes' (1986) argument that safety climate comprised 3 stable factors.
Hofmann and Stetzer (1996)	US Chemical processing (*n*= 204 for analysis)	Questionnaire comprising published scales and scales developed specifically for the study. 9 items were based on Zohar's (1980) safety climate scale	Role overload, perceptions of work group processes, approach intentions, unsafe behaviours	<u>Outcome measures:</u> OSHA recordable accidents for previous 2 years, self reported unsafe behaviours, <u>Analysis:</u> Regression (ordinary least squares), correlations	Role overload, group processes, safety climate, and intentions to approach were related to unsafe behaviours. Intentions to approach mediated the relationship between group processes and unsafe behaviours. At the group level, safety climate, group processes, intentions to approach, and unsafe behaviours were related to OSHA recordable accidents.
Diaz and Cabrera (1997)	Spain 3 Airport ground handling companies (*n*=166)	40 item questionnaire, developed from brainstorming sessions and literature review	Safety policy, productivity vs. safety, group attitudes, prevention strategies, perceived safety level on site, perceived safety level on job	<u>Outcome measures:</u> Self reported safety level (incl. previous/ probability of future incidents <u>Analysis:</u> Inter-company differences using ANOVA, correlations, regression	Safety climate discriminates between organizations with different levels of safety, especially for the safety policy factor, which includes management commitment. The second most important dimension is workforce perceptions about the organizational philosophy of productivity vs. safety, although in some organizations productivity and safety are seen as compatible.
Williamson et al. (1997)	Australia 7 manufacturing sites (*n*=660, 42%)	62 item questionnaire, developed from literature and themes of previous questionnaires	Safety awareness, safety responsibility, safety priority, management safety commitment, safety control, safety motivation, safety activity, safety evaluation	<u>Outcome measures:</u> self reported accident involvement, perceptions of workplace dangers <u>Analysis:</u> Exploratory factor analysis, one-way ANOVA	Factor analysis revealed an underlying 5-factor structure, comprising motivation, positive safety practice, risk justification, fatalism, optimism. Workers who had experienced accidents reported poorer safety practices and less rationalisation of the risks in their workplace. Respondents who perceived dangers in their workplace also tended to justify unsafe working and be more optimistic regarding risk.
Carroll (1998)	US Nuclear power plant (*n*=130)	45 item questionnaire plus 2 open questions, developed from literature review, group interviews based on the results of the questionnaire	Questionnaire factors: management support, openness, knowledge, work practices, attitudes	No outcome measures <u>Analysis:</u> Questionnaire data were analysed in descriptive manner (i.e. % agree/ disagree); interview data were thematically grouped	The results of the safety culture survey and group interviews were fed back to management as part of a culture improvement process. Although the culture was assessed as being essentially healthy, it was found that management behaviours were too hierarchical and the role of the supervisor was undermined. Employees were worried about being blamed for mistakes and there was a lack of positive reinforcement for safety behaviours
Cox et al. (1998)	UK 13 manufacturing companies (*n*=3329, 73%)	19-item questionnaire developed for use in manufacturing and piloted using discussion groups with safety professionals and employees.	Management action, quality of safety training, personal safety actions, employee appraisals of organizational commitment to safety.	<u>Outcome measures:</u> Employee appraisals of organizational commitment to safety <u>Analysis:</u> ANOVA, multiple linear regression, structural equation modelling	Permanent workers had generally higher perceptions than managers, supervisors, and temporary workers. Management actions for safety was the strongest predictor of employee appraisals of organizational , followed by training and personal actions. In SEM analysis, personal actions drops out and management actions emerges as a much stronger predictor than training, although there is a strong reciprocal relationship between them. Management actions was the only predictor of personal actions.
Cheyne et al. (1998)	Multinational Manufacturing (*n*=915)	Questionnaire based on Cox and Cox (1991)	Perceptions of physical work environment, workplace hazards, attitudes to safety management	<u>Outcome measures:</u> Employees' self reported safety activities <u>Analysis:</u> Structural Equation Modelling (SEM)	Employee attitudes to management directly influenced safety activities and indirectly influence individual responsibility for safety
Lee (1998)	UK Nuclear reprocessing plant (*n*=5296)	172 item questionnaire, developed by literature review and 5 mixed-level focus groups	Questionnaire domains: safety procedures, risk, permit-to-work (PTW), job satisfaction, safety rules, training, participation, control of safety, plant design	<u>Outcome measures:</u> 3-day loss-time accidents <u>Analysis:</u> Exploratory factor analysts, *t*-tests, discriminant function analysis	19 factors were identified under the following headings: safety procedures (1 factor), risks (3), PTW (3), job satisfaction (4), safety rules(2), training(2), participation(1), control(2), design(1). Most factors discriminated between accident and non-accident groups.
Mearns et al. (1998)	UK 10 offshore oil installations (*n*=722, 33%)	Offshore Safety Questionnaire (OSQ), developed from previous	Work environment (2 scales from Moos & Insel, 1974), job	<u>Outcome measures:</u> Self-reported accidents (in previous 2 years on site);	Employees who had not had an accident reported significantly more safety behaviours, job communication, and stronger attitudes towards

		research, literature review, and focus groups	communication, safety behaviour, risk perception, safety attitudes, accident history	Analysis: Descriptive analysis by factor (i.e. % agree/ disagree), Exploratory factor analysis, *t*-tests, ANOVA	work hazards (i.e. the non-accident group felt safer at work). They were also happier with accident prevention and mitigation measures than the accident group. However, there were no significant differences between accident and non-accident groups for the work climate variables of work pressure or job security. No differences in attitudes to the OIM (site manager) were found. The accident group were more positive towards their own responsibility for safety.
Thompson et al. (1998)	US 2 aviation manufacturing samples: 1992 (*n*= 350, 69%), 1995 (*n*= 329, 50%)	Questionnaire comprising published scales (i.e. Manager and supervisor support scales replicated from Dedobeleer & Beland, 1991)	Organizational politics, management support for safety, supervisor support, supervisor fairness, workplace safety perceptions, goal congruence (1992 only)	Outcome measures: Perceived safety conditions, self reported safety compliance, accident frequency rate from company records Analysis: Confirmatory Factor Analysis (CFA), Structural Equation Modelling (SEM)	Managers and supervisors play important but different roles in maintaining workplace safety. Managers influence through politics of communication and have a direct impact on safety conditions. Supervisors influenced safety compliance through fairness of interaction.. Data collected in 1992 was used to construct a model which was confirmed with 1995 data from same organization.
Cheyne et al. (1999)	UK Manufacturing, Dairy produce, Transport, Workforce, (*n*= 2429 workforce, 67%)	Cox and Cox (1998) safety climate questionnaire with minor contextual alterations	Management actions and responsibility, Personal actions and responsibility, Safety training, employee appraisals of organizational commitment to safety.	Outcome measures: employee appraisals of organizational commitment to safety Analysis: ANOVA, Structural Equation Modelling (SEM) using EQS	Appraisals of commitment were strongly predicted by management actions and responsibility, and less strongly predicted by quality of safety training in all samples. There was also a strong reciprocal relationship between these predictors. Attitudes to management actions were related to personal actions and responsibility in manufacturing and dairy produce, but not in transport. There was a weak but significant negative relationship between training and personal actions and responsibility across all 3 samples. Evidence that the architecture of safety climate is not stable across industries.
Clarke (1999)	UK Train operating companies, workforce (train drivers, *n*=186), supervisors (*n*=55), senior managers (*n*=71) Total response rate= 22%	75 item Questionnaire, developed on the basis of accident reports and discussions with managers. (25 unique items completed 3 times: from personal viewpoint then from view of worker/ supervisor/ manager as appropriate)	Unsafe conditions, managerial decisions, working conditions, local management, line functions	No outcome measures Analysis: Exploratory factor Analysis, one-way MANOVA	A novel method was used to assess the degree of shared perceptions of culture between workers (train drivers), supervisors, and managers. Each level was aware that a shared perception of safety priorities did not exist. In-group perceptions were not always accurate and were sometimes biased (e.g. the workforce thought that supervisors were more concerned about safety than senior managers when this was not the case). There was partial support for the hypothesis that workers base their perceptions of senior managers on their perceptions of local management and supervisors.
Tomas et al. (1999)	Spain 'High-risk companies', 3 workforce samples: 1: *n*= 123, 76%, 2: *n*= 182, 61%, 3: *n*= 124, 76%, total *n*= 429	Questionnaire comprised of scales that are published (e.g. worker's attitude towards safety from Leather, 1988), and those that were developed specifically.	Safety climate, supervisors' safety response, co-workers' safety response, worker attitude towards safety	Outcome measures: 4 self-report measures: safety behaviour, perception of actual risk, occurrence of accidents, perceived level of intrinsic hazards Analysis: Structural Equation Modelling (SEM) using EQS 3.0	Models for 2 of the 3 samples showed acceptable fit to the data. Safety climate was a direct predictor of supervisors' response, and a weak to non-significant predictor of worker behaviour and co-worker response. Supervisors' response was a central variable in the models, and linked climate with worker behaviour. In turn, behaviour, combined with assessment of hazards to influence perceptions of actual risk, the only variable in the model to be directly predictive of accidents.
Brown et al. (2000)	US Steel industry (*n*= 551 workforce, 69%)	Questionnaire designed specifically for the study and developed using in-depth tours, interviews, focus group. Was piloted on other sites.	Safety climate, pressure, cavalier attitude, safety efficacy, safe work behaviour	Outcome measures: Self report frequencies of self and co-worker adherence to safety procedures, safety attitudes, safety efficiency Analysis: Covariance structure analysis (CVA)	Safety climate was negatively related to supervisory pressure, indicating that positive safety climate is characterised by a low-pressure working environment. In turn, pressure positively influenced safe behaviour directly, was positively related to cavalier attitude, and negatively elated to safety efficacy. Safety hazards were found to have a negative impact on perceptions of safety climate.
Mearns et al. (2000)	UK Offshore oil and gas industry (13 installations) 1998: *n*=682; 1999: *n*=806	Offshore Safety Questionnaire (OSQ), developed from previous research, literature review, and focus groups	Satisfaction with safety activities, workforce involvement in health and safety planning, communication about health and safety, supervisor competence, management commitment to safety	Outcome measures: 3-day loss time incidents, RIDDOR data, near misses, self-reported accidents Analysis: Structural Equation Modelling (SEM) using EQS	In 1998, involvement was negatively related with the 3-day LTI rate. In 1999, involvement was negatively related with RIDDOR rate, and communication was negatively associated with dangerous occurrences and RIDDOR rate.
Griffin and Neal (2000)	Australia Manufacturing and mining (*n*= 1403 workforce members. 1264 used in analysis, response rates not available as data were obtained from archival records)	81-item questionnaire survey designed specifically for the study	Management values, safety inspections, personnel training, safety communication, safety knowledge, safety compliance, safety participation	Outcome measures: Self reported safety compliance and safety participation Analysis: Confirmatory Factor Analysis (CFA), Structural Equation Modelling (SEM)	This study treats safety as a higher-order factor, defined by workforce perceptions of workplace systems. Safety climate was found to reflect management values, safety communication, safety practices, safety training, and safety equipment. Safety climate was found to influence workforce compliance and participation indirectly through a strong relationship with safety knowledge, and through weaker (but significant) relationships with compliance motivation and participant motivation. There was also an unexpected negative relationship between compliance motivation and safety participation.
Neal, et al. (2000)	Australia Healthcare (*n*= 525 workforce, 56%)	59-item questionnaire comprising scales that are published (e.g. organizational climate, Hart et al., 1996), and those that were developed specifically.	Organizational climate, safety climate, determinants of safety performance (knowledge, motivation), components of safety performance (compliance, participation)	Outcome measures: Self reported safety compliance and safety participation Analysis: Structural Equation Modelling (SEM)	Organizational climate had a higher-order influence on safety climate which influenced safety compliance and safety participation indirectly through the determinants of safety knowledge and safety motivation. There was also an unexpected direct influence of safety climate on safety participation.
Zohar (2000)	Israel Metal processing plant (*n*=534 production workers in 53 work	23- item safety climate questionnaire based on critical incident technique plus the Task Load Index	Supervisory action, supervisory expectation, role overload, expert ratings of subunit risk,	Outcome measures: Microaccidents (i.e. first aid injuries) collected during 5 months after	The results support the hypothesis that safety climate is a group-level construct. There was strong within-group homogeneity between employees regarding supervisor safety practices,

	groups)	(Hart & Staveland, 1988), Supervisor and expert ratings of risk.	supervisor ratings of job risk	questionnaire completion Analysis: Exploratory factor analysis, correlations, within-group homogeneity, one-way ANOVA, ordinary least squares regression, hierarchical linear modelling	these perceptions varied between work-groups. Group perceptions of supervisor action and supervisor expectation were significant predictors of minor injuries within the subunit for the 5 months post-questionnaire. Perceptions of supervisor expectation also negatively correlated with lost-days accidents, although supervisor action did not.

References

Alexander, M., Cox, S., & Cheyne, A. (1995, 2nd February). *The concept of safety culture within a UK offshore organisation.* Paper presented at the Understanding Risk Perception Conference, Aberdeen.

Brown, K. A., Willis, P. G., & Prussia, G. E. (2000). Predicting safe employee behaviour in the steel Industry: Development and test of a socio-technical model. *Journal of Operations Management, 18*, 445-465.

Brown, R. L., & Holmes, H. (1986). The use of a factor analytic procedure for assessing the validity of an employee safety climate model. *Accident Analysis and Prevention., 18*(6), 445-470.

Cabrera, D. D., Isla, R., & Vilela, L. D. (1997, August). *An evaluation of safety climate in ground handling activities.* Paper presented at the Aviation Safety, Proceedings of the IASC-97 International Aviation Safety Conference, Netherlands.

Carroll, J. S. (1998). Safety culture as an ongoing process: Culture surveys as opportunities for enquiry and change. *Work and Stress, 12*(3), 272-284.

Cheyne, A., & Cox, S. (1995, November). *Uncovering safety culture.* Paper presented at the Work and Well-being: An Agenda for Europe Conference, Nottingham.

Cheyne, A., Cox, S., Oliver, A., & Tomas, J. M. (1998). Modelling safety climate in the prediction of levels of safety activity. *Work and Stress, 12*, 255-271.

Cheyne, A., Tomas, J. M., Cox, S., & Oliver, A. (1999). Modelling Employee Attitudes to Safety: A Comparison Across Sectors. *European Psychologist, 4*(1), 1-10.

Clarke, S. (1999). Perceptions of organizational safety: Implications for the development of safety culture. *Journal of Organizational Behaviour, 20*, 185-198.

Cooke, R. A., & Lafferty, J. C. (1989). *Organizational Culture Inventory: OCI*. Plymouth, MI: Human Synergistics.

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

Cox, S., & Cox, T. (1991). The structure of employee attitudes to safety: A European example. *Work and Stress, 5*, 93-106.

Cox, S., & Cox, T. (1996). *Safety, Systems and People*. Oxford: Butterworth-Heinemann.

Cox, S., & Flin, R. (1998). Safety culture: philosopher's stone or man of straw? *Work and Stress, 12*(3), 202-216.

Cox, S. J., & Cheyne, A. J. T. (2000). Assessing safety culture in offshore environments. *Safety Science, 34*, 111-129.

Coyle, I., Sleeman, S., & Adams, D. (1995). Safety climate. *Journal of Safety Research, 22*, 247-254.

Cullen, H. L. (1990). *The public inquiry into the Piper Alpha disaster* (Report to the Parliament by the Secetary of State for Energy by Command of Her Majesty Vols. 1 and 2). London: HMSO.

Dedobbeleer, N., & Beland, F. (1991). A Safety Climate Measure for Construction Sites. *Journal of Safety Research, 22*, 97-103.

Dedobbeleer, N., & Beland, F. (1998). Is risk perception one of the dimensions of safety climate? In A. Freyer & A. Williamson (Eds.), *Occupational Injury: Risk prevention and Intervention.* (pp. 73-81). London: Taylor & Francis.

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*, 619-654.

Diaz, R., & Cabrera, D. (1997). Safety climate and attitude as evaluation measures of organisational safety. *Accident Analysis and Prevention, 29*(5), 643-650.

Donald, I., & Canter, D. (1994). Employee attitudes and safety in the chemical industry. *Journal of Loss Prevention in the Process Industries, 7*, 203-208.

Fazio, R. H. (1986). How do attitudes guide behavior? In R. M. Sorrentino & E. T. Higgins (Eds.), *The Handbook of motivation and cognition: Foundations of social behavior* (pp. 204-243). New York: Guilford Press.

Fennell, D. (1988). *Investigation into the King's Cross underground fire*.: Department of Transport, HMSO.

Ferguson, E., & Cox, T. (1993). Exploratory Factor Analysis: A Users' Guide. *International Journal of Selection and Assessment, 1(2)*, 84-94.

Ferguson, E., & Patterson, F. (1998). The Five Factor model of personality: Openness a distinct but related construct. *Personality and Individual Differences, 24*(6), 789-796.

Flin, R., Mearns, K., Fleming, M., Gordon, R. (1996). *Risk Perception and Safety in the Offshore Oil and Gas Industry.* (OTH 94454). HSE Books, Suffolk.

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

Glennon, D. E. (1982). *Safety climate in organisations. Ergonomics and occupational health.* Paper presented at the 19th Annual Conference of the Ergonomics society of Australia and New Zeland.

Griffin, M. A., & Neal, A. (2000). Perceptions of safety at work: A framework for linking safety climate to safety performance, knowledge and motivation. *Journal of Occupational Health Psychology, 5*(3), 347-358.

Guldenmund, F. W. (2000). The nature of safety culture: a review of theory and research. *Safety Science, 34*(1), 215-257.

Health and Safety Commission. (1993). *Organising for Safety: Third Report of the Human Factors Study Group of ACSNI (Advisory Committee on the Safety of Nuclear Installations)*. Sudbury: HSE Books.

Health and Safety Executive. (1997b). The Health and Safety Climate Survey Tool: HSE.

Hidden, A. (1989). *Investigation into the Clapham Junction Railway Accident*.: Department of Transport, HMSO.

Hofstede, G. (1980). *Culture's consequenses: International differences in work-related values*. London: Sage.

IAEA. (1986). *Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident* (Safety Series 75-INSAG-4). Vienna: International Safety Advisory Group.

Keenan, V., Kerr, W., & Sherman, W. (1951). Psychological Climate and Accidents in an Automotive Plant. *Journal of Applied Psychology, 35*, 108-111.

Kleinke, C. L. (1984). Two Models for Conceptualising the Attitude-Behavior Relationship. *Human Relations, 37*(4), 333-350.

Lee, T. (1998). Assessment of safety culture at a nuclear reprocessing plant. *Work and Stress, 12*, 217-237.

Lewin, K., Lippitt, R., & White, R. K. (1939). Patterns of aggressive behaviour in experimentally created social climates. *Journal of Social Psychology, 10*, 271-301.

Likert, R. (1961). *New patterns of management*. New York: McGraw-Hill.

Likert, R. (1967). *The human organization: Its management and value.* New York: McGraw Hill.

Litwin, G. H., & Stringer, R. A. (1968). *Motivation and organizational climate*. Boston: Harvard University, Graduate School of Business Administration.

Marek, J., Tangenes, B., & Hellesoy, O. H. (1985). Experience of risk and safety. In O. H. Hellesoy (Ed.), *Work Environment Statfjord. Work Environment, Health and Safety on a North Sea Platform*. Oslo: Universitetsforlaget.

McGregor, D. (1960). *The human side of the enterprise*. New York: McGraw-Hill.

Mearns, K., Flin, R., Fleming, M., & Gordon, R. (1997). *Human and Organisational Factors in Offshore Safety* (OTH 543). Suffolk: Offshore Safety Division, HSE books.

Mearns, K., Flin, R., Gordon, R., & Fleming, M. (1998). Measuring safety climate on offshore installations. *Work and Stress, 12*(3), 238-254.

Mearns, K., Whitaker, S. M., & Flin, R. (2001). Benchmarking safety climate in hazardous environments: a longitudinal, interorganizational approach. *21, 4*, 771-786.

Neale, A., Griffin, M. A., & Hart, P. M. (2000). The impact of organisational climate on safety climate and individual behaviour. *Safety Science, 34*, 99-109.

Niskanen, T. (1994b). Safety climate in the road administration. *Safety Science, 17*, 237-255.

Oppenheim, A. N. (1992). *Questionnaire design, interviewing and attitude measurement.* London: Cassell.

Ostrom, L., Wilhelmsen, C., & Kaplan, B. (1993). Assessing safety culture. *Nuclear Safety, 34*(2), 163-172.

Perrow, C. (1984). *Normal accidents*. New York: Basic Books.

Pervin, L. A. (2003). *The Science of Personality* (2nd ed.). New York, NY: Oxford University Press.

Pidgeon, N. (1991). Safety culture and risk management in organizations. *Journal of Cross-Cultural Psychology, 22*(1).

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

Pritchard, R. D., & Karasick, B. W. (1973). The effect of organizational climate on managerial job performance and job satidfaction. *Organizational Behaviour and Human Performance, 9*, 126-146.

Reason, J. (1997). *Managing the risks of organisational accidents*. Aldershot: Ashgate.

Reason, J. (1998). Achieving a safe culture: Theory and practice. *Work and Stress, 12*(3), 293-306.

Reichers, A. E., & Schneider, B. (1990). Climate and Culture: An Evolution of Constructs. In B. Schneider (Ed.), *Organisational Climate and Culture*. San Francisco: Jossey-Bass.

Roberts, K. H., Rousseau, D. M., & La Porte, T. R. (1994). The culture of high reliability: Quantitative and qualitative assessment aboard nuclear-powered aircraft carriers. *Journal of High Technology Management Research, 5*, 141-161.

Rochlin, G., LaPorte, T., & Roberts, K. H. (1987). The self-designing high reliability organization: Aircraft carrier flight operation at sea. *Naval War College Review, 40*, 76-90.

Rundmo, T. (1994). Associations between safety and contingency measures and occupational accidents on offshore petroleum platforms. *Scandinavian Journal of Work and Environmental Health, 20*, 128-131.

Schein, E. H. (1985). *Organizational culture and leadership*. San Francisco: Jossey-Bass.

Schein, E. H. (1992). *Organizational culture and leadership* (2nd ed.). San Francisco: Jossey-Bass.

Schneider, B. (1975). Organizational climates: an essay. *Personnel Psychology, 28*, 447-479.

Schneider, B. (1990). *Organizational climate and culture*. San Francisco: Jossey-Bass.

Sheen, M. J. (1987). *M.V. Herald of Free Enterprise*. London: HMSO: Department of Transport.

Smith, M., Cohen, H., Cohen, A., & Cleveland, R. (1978). Characteristics of successful safety programs. *Journal of Safety Research, 10*(1), 5-15.

Thompson, R. C., Hilton, T. F., & Witt, L. A. (1998). Where the safety rubber meets the shop floor: a confirmatory model of management influence on workplace safety. *Journal of Safety Research, 29*(1), 15-24.

Tomas, J. M., Melia, J.L., & Oliver, A.M. (1999). A cross validation of a structural equation model of accidents: organisational and psychological variables as predictors of work safety. *Work and Stress, 13*(1), 49-58.

Uttal, B. (1983). The corporate culture vultures. *Fortune Magazine, 17 October*.

Vaughan, D. (1996). *The Challenger launch decision. Risky technology, culture, and deviance at NASA*. Chicago: The University of Chicago Press.

Weick, K. E. (1987). Organisational culture as a source of high reliability. *California Management Review, XXIX*, 112-127.

Weick, K. E. (1995). *Sensemaking in Organizations*. Thousand Oaks, CA: Sage.

Weick, K. E., & Roberts, K. H. (1993). Collective Mind in Organizations: Heedful Interrelating on Flight Decks. *Administrative Science Quarterly, 38*, 357-358.

Weick, K. E., & Sutcliffe, K. M. (2001). *Managing the Unexpected: Assuring High Performance in an Age of Complexity*. San Francisco: Jossey Bass.

Whitaker, S., & Yule, S.J. (under review). Organizational safety and nonlinear dynamics.

Williams, A., Dobson, P., & Walters, M. (1989). *Changing Culture: New Organizational Approaches*. London: IPM.

Williamson, A., Feyer, A., Cairns, D., & Biancotti, D. (1997). The development of a measure of safety climate: the role of safety perceptions and attitudes. *Safety Science, 25*(15-27).

Yule, S. J., Flin, R., & Murdy, A. J. (2001). *Modelling managerial influence on safety climate.* Paper presented at the SIOP (Society of Industrial and Organizational Psychologists) conference, San Diego, CA.

Yule, S. J., O'Connor, P., & Flin, R. (under review). Testing the structure of a generic safety climate survey instrument: Implications for applied research and practice.

Zohar, D. (1980). Safety Climate in Industrial Organizations: Theoretical and Applied Implications. *Journal of Applied Psychology, 65*(1), 96-102.

Zohar, D. (2000). A Group-Level Model of Safety Climate: Testing the Effect of Group Climate on Microaccidents in Manufacturing Jobs. *Journal of Applied Psychology, 85*(4), 587-596.