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Measuring safety climate: identifying the common features☆

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Abstract

In UK industry, particularly in the energy sector, there has been a movement away from 'lagging' measures of safety based on retrospective data, such as lost time accidents and incidents, towards 'leading' or predictive assessments of the safety climate of the organisation or worksite. A number of different instruments have been developed by industrial psychologists for this purpose, resulting in a proliferation of scales with distinct developmental histories. Reviewing the methods and results from a sample of industrial surveys, the thematic basis of 18 scales used to assess safety climate is examined. This suggests that the most typically assessed dimensions relate to management (72% of studies), the safety system (67%), and risk (67%), in addition themes relating to work pressure and competence appear in a third of the studies. © 2000 Elsevier Science Ltd. All rights reserved.

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1. Introduction

In the 'high reliability' industries, where significant hazards are present (even if rarely realised), operating companies and their regulators pay considerable attention to safety assessment. In recent years there has been a movement away from safety measures purely based on retrospective data or 'lagging indicators' such as fatalities, lost time accident rates and incidents, towards so called 'leading indicators' such as

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safety audits or measurements of safety climate. It can be argued that these are predictive measures enabling safety condition monitoring (Flin, 1998), which may reduce the need to wait for the system to fail in order to identify weaknesses and to take remedial actions. This can also be conceptualised as a switch from 'feedback' to 'feedforward' control (Falbruch and Wilpert, 1999).

The shift of focus has been driven by the awareness that organisational, managerial and human factors rather than purely technical failures are prime causes of accidents in high reliability industries (Weick et al., 1999). The nuclear power industry recognised the importance of organisational culture following the Chernobyl accident (IAEA, 1986) and encouraged operators to assess the safety culture on their plants (ACSNI, 1993; IAEA, 1991, 1997). The idea of a safety culture is predated by an extensive body of research into organisational culture and climate, where culture embodies values, beliefs and underlying assumptions, and climate is a descriptive measure reflecting the workforce's perceptions of the organisational atmosphere (Gonzalez-Roma et al., 1999). Longstanding debates as to the nature, supremacy and applicability of culture versus climate in organisational theory are now being echoed by the safety researchers. Cox and Flin (1998) reviewed some of the arguments and concluded that in terms of operationalising the concept into a practical measurement tool for managers, safety climate was the preferred term when psychometric questionnaire studies were employed as the measurement instrument (Hale and Hovden, 1998). Safety climate can be regarded as the surface features of the safety culture discerned from the workforce's attitudes and perceptions at a given point in time (Schneider and Gunnarson, 1991; Cox and Flin, 1998; HSE, 1999). It is a snapshot of the state of safety providing an indicator of the underlying safety culture of a work group, plant or organisation. If this concept is to be effectively translated into an operational measure for safety management then a number of questions need to be addressed. What are the key features of a good safety culture that can be assessed by a climate measure? Can these be regarded as generic features of the safety culture or are they specific to certain companies, industries or cultures? Is there any evidence that these features are indicative of the state of safety, for instance do they relate to other safety measures (e.g. accident rates)?

The International Atomic Energy Authority provides a set of safety culture indicators in the form of a question set. Those that relate to operations (rather than design or regulation), cover definition of responsibilities, training, management selection, reviews of safety performance, highlighting safety, workload, relation between management and regulator, management attitudes, individual attitudes, local work practices and supervision (IAEA, 1991). A British advisory committee on human factors in nuclear safety identified senior management commitment, management style, management visibility, communication, pressure for production, training, housekeeping, job satisfaction and workforce composition as key indicators of the safety culture. It recommended the assessment of safety climate using a survey approach (ACSNI, 1993), advice now endorsed by the UK safety regulator (HSE, 1999). For managers and researchers selecting a safety climate measure, is there a common set of organisational, management and human factors that are being regularly included in measures of safety climate?

Recent academic interest in the measurement of safety climate, has resulted in a proliferation of assessment instruments, typically in the form of self-report questionnaires administered as large-scale surveys in different sectors, principally the energy industries, but also in manufacturing and construction. It could be argued that the lack of a unifying theoretical model in this area (Guldenmund, 2000; Williamson et al., 1997) is a reflection of the state of development of this field, where an inductive rather than a deductive approach is in operation. However, it does mean that these instruments tend to have distinct developmental histories, often customised to the sponsoring organisation's requirements. In the main, they are designed to measure a set of themes derived from reviews of the safety research literature. Interviews and focus groups conducted at the worksite are used to reveal particular issues concerning the workforce and to tailor the instrument accordingly. Only a few independent replications of questionnaires and examination of the resulting factor structures have been undertaken (e.g. Dedobbeleer and Beland, 1991). The recent emergence of a number of new scales seems to have triggered efforts to address this problem by comparing safety climate scales from different studies. The initial reviews demonstrated that measures vary significantly in almost all respects — content, style, statistical analysis, sample size, sample composition (workers, supervisors, managers), industry and country of origin. Factor analysis is typically used for identification of an underlying structure but numbers of items range from 11 to 300 and thus solutions range from two to 19 factors. Drawing direct comparisons between factor labels and (loading) items across these measures remains problematical due not only to the methodological inconsistencies outlined above, but also to cultural and language differences across both countries and industries. Williamson et al. (1997) examined seven reports measuring safety climate and concluded that eight factors could be discerned, four measuring attitudes and four perceptions, although they presented no detailed analysis of which of these eight factors were derived from particular questionnaires. Dedobbeleer and Beland (1998) reviewed 10 safety climate instruments and argued that only two factors, management commitment and worker involvement, had been properly replicated across studies. Coyle et al. (1995) found different factor structures using the same safety climate scale in two Australian health care organisations and concluded that the likelihood of establishing a universal and stable set of safety climate factors was "highly doubtful" (p. 253).

Thus we have very limited evidence for or against a common set of core features, notwithstanding a prevailing belief that, "a specific example of good practice may not always be directly transferable, unlike the underlying features and attributes which are universally applicable" (IAEA, 1997, p. i). As the number of scales multiplies, a superficial scrutiny of their component themes does suggest that a basic set of features is beginning to emerge. Thus the field may be moving towards the position where a base taxonomy of fundamental safety climate attributes could be distilled from a proliferation of scales and items, akin to the 'Big Five' factors in personality measurement[1] (Barrick and Mount, 1991). To test this proposition, a

[1] We are indebted to Neville Stanton and Ivan Robertson for highlighting this analogy.

larger sample of safety climate studies was examined with particular reference to the composition of each questionnaire and its validation.

2. Thematic analysis

Following a literature search, 18 published reports of safety climate surveys were identified. The selection criteria were that the sample size should be greater than 100, the report should be presented in English, and that only industrial sectors were included (i.e. excluding retail, clerical, health, etc.). In the final sample 50% of studies are from the energy/petrochemical sector, which is leading this field with safety climate scales becoming established as part of their safety management systems. As the purpose of the review was to compare instruments, only one report was selected where the same instrument had been used by the same research team in two or more studies. Where the original scale items were not listed, the report was scrutinised for details of scale construction and validation and these are summarised in Table 1. For each scale, the main dimensions were extracted (100 in total) and relabelled using a simplified number (35) of themes. This is a crude recategorisation as even when a factorial structure has been reported, the labelling of factors is not entirely consistent (Kline, 1994) and in several papers, the original items had not been reported, making it difficult to check the factor content. The terms feature, dimension or theme are used rather than factor because not all studies employed statistical structural analysis in their scale development, and the possibility of factor intercorrelation has not been taken into account.

3. Emergent themes

As can be seen in Table 1, a wide range of climate features is assessed. In general these are workforce perceptions of (or attitudes toward) the current 'state' of some facet of the organisation (e.g. management, safety procedures, staff competence). In some instruments, measures of individual dispositions (e.g. optimism, fatalism), personality (sensation seeking) or self-reported work behaviours (e.g. risk taking, rule violation or accident reporting) are included. No attempt is made to distinguish these psychological constructs and the listing covers only the authors' labels for their themes or topics. There is considerable overlap of item topics loading onto differently labelled dimensions and so the table must be regarded as a preliminary synthesis. The most common themes — mentioned in six or more studies (a third of the sample) — in the reclassification labels are summarised in Table 2.

From Table 2 it can be seen that three themes appeared in two-thirds of the questionnaires, these related to management, safety systems and risk (in fact these themes appeared more than once in some instruments). Two other themes were found to occur in a third of the questionnaires, namely competence and work pressure. In a similar review of safety climate themes (Guldenmund, 2000), using 15 studies (11 from research teams sampled here), the most frequently measured

Table 1
Review safety climate

Research team	Industry (*n*)	Questionnaire	Categories	Features (recoded)	Validation
Energy/Chemic.					
Lee (1998). Study undertaken 1991	Nuclear reprocessing plant, UK (5296)	Literature/focus groups 172 items (not listed)	Safety procedures Risks PTW Job satisfaction Safety rules Training Participation Control of safety Design	Procedures Risk Safety system Job satisfaction Rules Competence Participation Safety system Design	Most factor scores discriminated self-reported accident from non-accident groups
Cox and Cox (1991)	Gas company depots across Europe (630)	Literature/management discussions 18 items	Personal scepticism Individual responsibility Work environment Safety arrangements Personal immunity	Scepticism Responsibility Work environment Safety system Personal immunity	None
Rundmo (1992, 1994)	Oil companies (5). Eight offshore platforms Norway (915)	Literature/sources of risk from accident statistics	Risks Job stress Work conditions Safety measures Sensation seeking	Risk Time independence Work environment Participation Safety system Sensation seeking	All factors related to self-reported accidents LISREL models
Donald and Canter (1994)	10 chemical sites, UK (602)	Literature 167 items (not listed) (multidimensional scaling)	People Attitudes Activities	Self/ Workmatesd/reps Management Competence Safety behaviour	Scales correlated (ex safety reps) with self-reported accident rates across sites
Ostrom et al. (1993)	Nuclear engineering lab (USA) (4000)	Literature Interviews 88 items No structural analysis	Safety awareness Teamwork Commitment Excellence, honesty	Safety awareness/ attitudes Work values Communication	Accident data by department some comments but no analysis reported

(*continued on next page*)

Table 1 (*continued*)

Research team	Industry (*n*)	Questionnaire	Categories	Features (recoded)	Validation
			Training Procedures, etc. (13)	Competence Procedures	
Alexander et al. (1995)	Oil company, UK Offshore and onshore (895)	Literature 36 items (details given of 28 factor-loading items)	Management commitment Need for safety Risk Blame Conflict/control Supportive environment	Management Safety need Risk Blame Control Support	No different safety climate scores accident versus non-accident groups
Budworth (1997)	Chemical 3 sites (UK) (*n* unspecified)	Literature review 22–32 items No structural analysis	Management commitment Supervisor support Safety systems Safety attitudes Safety reps	Management Supervisors Safety system Attitudes Safety reps	None
Mearns et al. (1997)	Offshore oil, UK 10 installations (722)	Literature review, focus groups 52 attitude items Three work climate scales from Moos and Insel (1974) Risk perception/safety satisfaction developed from Rundmo (1992)	Speaking up Violations Supervisors Rules/regulations Site management Work pressure Work clarity Communication Risk Safety measures	Safety reporting Violations Supervision Rules/procedures Management Work pressure Work clarity Communication Risk Safety system	Several attitude factors related to prior individual accident involvement but not work climate scales
Carroll (1998)	Nuclear power plant USA (115)	Literature 45 items (not listed — but provided to authors) No structural analysis	Management support Openness Knowledge Work practices Attitudes	Management Speaking up Competence Work practices Attitudes	None
Manufacturing					
Zohar (1980)	Factories (20) Israel, (400)	Literature-derived	Safety training	Competence	Safety inspectors' rankings

Table 1 (*continued*)

Research team	Industry (n)	Questionnaire	Categories	Features (recoded)	Validation
		40 items (not listed)	Management attitudes Promotion Level of risk Work pace Safety officer Social status Safety committee	Management Career Risk Work presure Safety system Peer judgement Safety system	of safety/accident prevention practices pos. correlation with climate (small n)
Brown and Holmes (1986)	Factories (10), USA (425)	Zohar questionnaire	Management concern Management activity Risk perception	Management Management Risk	Differences in climate perceptions. Between accident versus non-accident groups
Phillips et al. (1993)	Factory, UK (374)	Variation of Zohar's questionnaire 50 items	Management attitudes Risk Work place Management actions Safety officer/ Promotion/training/ committee	Management Risk Work pressure Management Safety system	None
Janssens et al. (1995)	Manufacturing (3 plants) US (300) France (241) Argentina (152)	Literature National Safety Council studies 20 items	Management concern Production as priority Safety as priority Safety level	Management Work pressure Safety system Risk	None (but cultural differences in factor structure)
Williamson et al. (1997)	Manufacturing (7 sites) Australia (660)	Literature/previous questionnaires 27 items	Personal motivation Positive safe practice Risk justification Fatalism/optimism	Management Safety system Risk Fatalism/optimism	Self-reported accidents classification predicted by optimism and safe practice
Transport					
Diaz and Cabrera (1997)	Airport ground staff 3 companies Spain (166)	Literature Brainstorming 40 climate items Not listed	Safety policy Productivity/safety Group attitudes Prevention strategies	Safety system Work pressure Peer support Safety system	Company expert ratings of safety align with safety climate rankings

(*continued on next page*)

Table 1 (*continued*)

Research team	Industry (n)	Questionnaire	Categories	Features (recoded)	Validation
		(+29 attitude items)	Safety level	Risk	
Construction					
Dedobbeleer and Beland (1991)	Construction, USA (384)	Version Brown and Holmes 9 items	Management commitment Worker involvement	Management Risk/involvement	None
Niskanen (1994)	Road construction, Finland, 85 work places (1890 workers +562 supervisors)	Literature 10 items plus 12 items for workers 11 items for supervisors	Changes job demands Attitudes to safety Work value Safety/production	Work pressure Supervision Work value Responsibility	Some item differences between high/low accident sites Factor structures varied slightly sups versus workers
Generic					
HSE (1997)	Mining, chemical, drink, food (UK) (3850) This is sold as a generic measure especially for use in small–medium sized organisations	Literature 74 items for managers 83 supervisors 80 workforce	Organisational commitment Risk taking Obstacles to safety Competence Management Personal role Accident reporting Supervisor Permit to work	Management Risk Obstacles Competence Management Role Accident reporting Supervisor Safety system	None To date no data sets from this scale have been published

dimensions related to management, risk, safety arrangements, procedures, training and work pressure (in that order). (Although he appears to have counted dimensions more than once from the same study.) Given the limitations of such a thematic analysis, it can be speculatively concluded that there are approximately three core themes (management, risk and safety arrangements) which have been repeatedly included in safety climate measures, along with a number of other dimensions emerging, although less frequently (work pressure, competence and procedures). Each of these topics will be considered in turn to indicate what is encompassed within the thematic label and to what extent a relevant literature exists to aid in their refinement.

3.1. Management

The prime theme deemed to be worthy of measurement in relation to a worksite's or organization's safety climate relates to perceptions of management attitudes and behaviours in relation to safety as well as to production, or other issues (selection, discipline, planning, etc.). This appears explicitly with a dimension label in 13 studies or implicitly (from inspecting the items), in every one of the 18 studies. In some cases, the label is used in an ambiguous fashion and therefore it can be difficult to discern which level of management is actually being assessed (senior managers, plant managers, or supervisors). This is not a trivial point as these levels of management have distinct roles and are perceived differently by the workforce (Clarke, 1999).

Several questionnaires included a separate factor relating to supervision, emphasising the undoubted importance of first-line supervisors in setting the work atmosphere and hence the safety climate for their operations. It generally is measured by respondents' satisfaction with supervision or their perceptions of the supervisors' attitudes and behaviours with respect to safety. The significance of the supervisor in safety management has long been realised: "The supervisor or foreman is the key man in industrial accident prevention. His application of the art of supervision to the control of worker performance is the factor of greatest influence in successful accident prevention" (Heinrich, 1959, p. 22). Studies of supervisor behaviour and leadership style in relation to workgroup safety are starting to identify critical behaviours (Simard and Marchand, 1994; Mearns et al., 1997) which could be used to increase the precision of scales assessing this aspect of management.

Table 2
Most common themes assessed in safety climate questionnaires[a]

1. Management (13)/supervision (4)
2. Safety system (12)
3. Risk (12)
4. Work pressure (6)
5. Competence (6)

[a] Figures in parentheses represent the number of studies in which this theme appears once or more.

It is hardly surprising that the role of management in determining the safety climate of the workplace appears so frequently, although an understanding of the processes relating management behaviours, their perception by the workforce and any resulting impact on workforce behaviours are rather less well established. While senior managers undoubtedly set the tone and tempo for organisational atmosphere, establish priorities and allocate resources, there is very little evidence that unravels how this actually works in practice. There have been surprisingly few studies on the impact of site or plant managers' behaviours on worker safety given that their influence is likely to operate in a more direct fashion than that of the more remote senior managers (Thompson et al., 1998). This topic seems to have been of more interest 20 years ago when leadership research was more popular and several studies investigated the relationship between managers' beliefs and leadership style and the accident rates on their sites (Andriessen, 1978; Eyssen et al., 1980). More recently, a survey on safety issues with 200 managers in charge of Britain's offshore oil installations revealed that they are so overburdened with administration and safety initiatives that they have inadequate time to maintain visibility and involvement at the worksites, behaviours that they believe to be critical for workplace safety (O'Dea and Flin, 1998). Dedobbeleer and Beland (1998) found evidence for only two core factors in a review of safety climate surveys, one of which they called management commitment. Cheyne et al. (1998) have recently reported management commitment as a prime factor in their predictive model of safety behaviours, giving some support to the primacy of this factor.

3.2. Safety system

The second very broad theme identified in almost every survey was labelled safety system and this encompassed many different aspects of the organisation's safety management system, including safety officials, safety committees, permit to work systems, safety policies, safety equipment. Generally respondents were asked to indicate their satisfaction with such aspects of the safety system or to indicate agreement/disagreement with statements relating to system performance. In some cases this is a dimension which companies may already be assessing using more conventional safety auditing procedures (e.g. ISRS, ROSPA; Glendon and McKenna, 1995) or sensing systems such as TRIPOD which identify 11 general failure types from both worksite questionnaires and accident analysis (Reason, 1997). Perception of the state of the safety systems is clearly an important component of a safety climate audit but where data on workforce perceptions are available from other measures used on site, this may not need to be included within a climate scale, allowing more attention to be devoted to other factors.

3.3. Risk

The risk theme is frequently included but appears in a number of conceptual guises, namely, self-reported risk taking, perceptions of risk/hazards on the worksite and attitudes towards risk and safety. Dedobbeleer and Beland (1998) considered whether risk perception was a fundamental component of a safety climate scale and speculated that it was closely linked to the concept of workers' involvement or responsibility for safety, one of their two identified safety climate dimensions. While this is perfectly feasible, they do not present any evidence to show that workers' risk perceptions and risk-taking behaviours are linked to their level of participation. Previous studies of risk perception in offshore workers (Rundmo, 1992; Flin et al., 1996) have shown that workers have fairly accurate perceptions of the risks they face but that this does not provide a sufficient explanation of why some workers continue to take risks (Cheyne et al., 1998). Factors relating to the work climate and motivation may play a more influential role in risk-taking behaviour and in turn these may be influenced by worker involvement as Dedobbeleer and Beland (1998) suggest.

In one or two studies, personality disposition variables in relation to risk, such as fatalism and optimism are included. These may have a direct effect on risk taking or an indirect effect on safety behaviours, influencing a worker's predisposition to speak up about safety or to become involved in safety initiatives. The merits of including personality variables in safety climate scales are somewhat debatable, given their historical failure to predict accident involvement (Lawton and Parker, 1998).

3.4. Work pressure

Factors relating to work pace and workload appear in a number of surveys and have been labelled work pressure. A related theme, which overlaps this variable (and the management and supervision factors) is the balance maintained between pressure for production and safety, now widely recognised as a key component of a safety culture (ACSNI, 1993). It only emerged twice as a separate theme but a scrutiny of items shows clearly that this is a central issue, even though the items may have loaded onto factors labelled risk, procedures or management. In a global economy of increased competitiveness, cost reduction and organisational restructuring, work pressure is very likely to influence safety climate at the worksite when time and resources become stretched. This factor demonstrates the importance of including *work* climate variables in the overall assessment of the state of safety (Falbruch and Wilpert, 1999).

3.5. Competence

The workforce's perception of the general level of workers' qualifications, skills and knowledge is the essence of this competence factor, with associated aspects relating to selection, training, competence standards and their assessment. This also is likely to be influenced by broader economic conditions such as the labour market for a particular industrial sector and available training budgets. The introduction of multi-skilling can be regarded as risky or protective depending on whether it is properly applied and resourced, and this aspect of competence may be relevant to assess when measuring safety climate.

In high reliability settings such as aviation or offshore oil production, there is an increasing emphasis on competence in non-technical skills (e.g. leadership, decision making) which are regarded as contributing factors to safe operations (Helmreich and

Merritt, 1998). These are usually taught on Crew Resource Management programmes (Flin and O'Connor, 2000) and as such training becomes more widespread, this aspect of the skill base may also need to be incorporated into a competence factor.

3.6. Procedures/rules

This theme only emerged in three studies sampled here, although there were items relating to procedures and rules in the other studies. However, Guldenmund (2000) identified this as one of the most frequently occurring themes in his review and for that reason it is discussed here. Perceptions of safety rules, attitudes to rules and compliance or violation of procedures are covered by this theme, which is also related to risk-taking behaviours as these can involve rule breaking. Some of these factors have been shown to relate to accident involvement in safety climate surveys (e.g. Lee, 1998) but causal relationships remain more obscure and are likely to be influenced by supervisor behaviour and work pressure variables. This issue is receiving increasing scrutiny in studies of worksite safety (Bax et al., 1998; Hudson et al., 1998; McDonald, 1998; Reason et al., 1998) which suggests that this is an issue that may merit inclusion in safety climate measures.

3.7. Summary

The foregoing review of safety climate measures has identified a number of common themes from measures of safety climate used in the industrial sectors (energy/ chemical, transport, construction and manufacturing). The most commonly measured dimensions relate to management, safety systems, risk, followed by work pressure and competence (and rules/procedures may be worthy of more attention). The actual item components of each theme are variable and are likely to be industry or even company specific, relating to particular work practices or policies (IAEA, 1997). At this stage it would be premature to regard these as a core set, akin to the 'Big Five' of the personality theorists. Although such a 'straw man' would be valuable if it generated as much controversy, theoretical scrutiny and critical examination as the Big Five model produced for personality research (De Raad, 1998).

It is not difficult to find support in the safety literature for this particular taxonomy, given that most of the safety climate questionnaires were derived from this source in the first place. There is some evidence that these particular themes would be supported by other empirical routes, such as comparative studies of site safety performance (Simard and Marchand, 1995; Shannon et al., 1997; Hale and Hovden, 1998), major accident pathologies (Reason, 1997; Turner and Pidgeon, 1997), and personal accident histories (Williamson and Feyer, 1990). These investigations, particularly the case studies, may help to identify other features of the underlying culture (e.g. blame, organisational learning) that safety climate scales should attempt to assess, or that may have to be evaluated by more qualitative research techniques.

Many questions remain to be investigated on an empirical basis. Is there sufficient evidence for a generic factor structure or are the components of safety climate associated with particular industrial sectors or cultural differences? How should data be aggregated and should the same issues be measured with workers, supervisors and managers? If a basic factor set can be established, it must be shown to be reliable, valid, sufficiently comprehensive and theoretically justifiable. Previous attempts to replicate factor structures of safety climate scales have not been entirely fruitful (Coyle et al., 1995; Dedobbeleer and Beland, 1998). Proposed factor structures will continue to be evaluated as reliability data build from research teams who have had the opportunity to administer similar versions of their scales across industrial sectors (Cheyne et al., 1999) and cultures (Janssens et al., 1995; Donald and Young, 1996; Freeman et al., 1998; Chunlin et al., 1999). While good industrial cooperation would be required, construct validity could be examined by comparing results from different climate scales administered to the same workforce.

4. Validation

The real test of the safety climate measures is validity, in terms of their power to reveal the level of site safety. The final column of Table 1 shows that validation of safety climate questionnaires has been undertaken in 10 of these studies, typically by comparison with retrospective accident data either in terms of self-reported accidents or accident rates for work sites. While results appear to be encouraging, a comprehensive meta-analysis of such studies is now required (Turner and Pidgeon, 1997 p. 186) and this would help to determine which factors fail to predict and could be dropped from climate measures. Structural equation modelling is beginning to indicate how factors interrelate and directly or indirectly influence safety behaviours (Cheyne et al., 1999). Validation correlates, other than accident data, might include quantified risk assessment calculations from the safety case, as there are some indications that these align with workforce perceptions of risk on offshore oil platforms (Fleming et al., 1998), existing safety audit records or self reports of unsafe behaviours (Hofman and Stetzer, 1996). Finally, managers remain primarily interested in what they should do to 'engineer a strong safety culture' (Reason, 1997) on the basis of their safety climate profiles. Examples of good practice using climate survey feedback are beginning to be reported (Donald and Young, 1996; IAEA, 1997; Carroll, 1998; Helmreich and Merritt, 1998) and where these are properly evaluated, they should result in a better understanding of the fundamentals of the safety climate.

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