



# Investigating employee perceptions of a framework of safety culture maturity

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## Abstract

A framework for the development of organisational safety culture based on Westrum's [Westrum, R., 1996. Human factors experts beginning to focus on organizational factors in safety. ICAO Journal October] typology of organisational communication had been formulated in a previous interview study. The framework had face validity based on the judgment of oil industry employees of five levels of safety culture maturity, and how their work experience translated into the framework. In order to assess whether the content of the framework was internally consistent in terms of the levels of safety culture, a further study was carried out. The detailed descriptions generated in the previous study were "unpicked" into their constituent statements and used in a safety culture questionnaire in order to investigate whether the statements formed statistically coherent and distinct groups relating to the levels of maturity. The questionnaire responses were submitted to principal components analysis (PCA). The component structures obtained were used to interpret the workforce's perception of the organisational safety culture in terms of the framework. Scales were constructed from the items that loaded on the components and were tested for reliability. Overall, this study provided some support for the safety culture maturity framework. The component structures provided partial support for the distinctions between the five levels of safety culture maturity and the internal consistency of the descriptions of the levels was generally supported by the analysis of the data. Participants perceived desirable features of safety culture to be associated with each other, and perceived undesirable aspects to group together in the same way. The framework of safety culture maturity requires further research attention to ensure its appropriateness and sound theoretical basis.

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## 1. Introduction

In recent years there has been a great deal of research interest in the notion of safety culture in high-risk industries (Arboleda et al., 2003; Cheyne et al., 2002; Clarke, 2003; Hudson, 2003; Mearns et al., 2004; Sorensen, 2002; Vredenburg, 2002). However, the cultural approach to the evaluation of organisational safety has been criticised as lacking a normative framework (Grote and Künzler, 2000). Analyses of safety culture tend to involve descriptions of the norms and assumptions more or less shared by the members of the organisation, and more or less supportive of fulfilling the organisation's purpose goals, but generally no conclusions about whether the culture is 'good' or 'bad' can be drawn. More than a decade ago, Pidgeon (1991) recommended the empirical investigation of 'good' and 'bad' safety cultures, but Cox and Cox (1996) noted the lack of empirical data on what constitutes such a good safety culture.

While it is generally assumed that developing a "positive" safety culture will improve safety performance, little guidance is provided on how organisations might achieve this goal (Clarke, 1999). Mearns et al. (2000) advised that well defined strategies need to be developed for improving organisational safety. An organisation with a poor safety culture might identify an overwhelming list of corrective actions, and would probably require guidance on how to improve its culture. Sorensen (2002), for example, pointed out a fundamental problem with the INSAG (International Nuclear Safety Advisory Group) approach to safety culture in that it specifies in great detail what should be included in an effective organisational safety culture, but provides little guidance on the overall criteria for acceptability.

On the other hand, systematic methods to compare the ways in which organisations manage safety have been presented in the literature. The main objective of research by McDonald et al. (2000) was to operationalise a model of safety management, which could effectively describe the safety management systems of different companies and differentiate between them. Mearns et al. (2000) provided a benchmarking system by which organisations could compare their relative safety performance and examine the reasons for differences, which was then used to identify and share best practice among those organisations.

To summarise, there is considerable agreement in academia and industry that research addressing the issues is necessary if theoretical and practical progress is to be made in the area of organisational safety culture. The theoretical framework underpinning the study reported here is Westrum's (1996) framework of communication in organisations. This was used as a basis to develop a safety culture framework that

1. provides a normative framework within which to consider what constitutes a 'good' or a 'bad' safety culture,
2. illustrates how safety culture could be improved within the context of the framework,
3. facilitates the comparison of organisational cultures, and subcultures.

The way in which the framework was developed, through interviews with senior oil executives working at a range of multinational oil companies and contracting companies with extensive experience in the industry, has been described in a previous paper

(Parker et al., in press). It was judged to have face validity in terms of interviewees' experience of the oil industry, and has since been used extensively by the company for which it was developed. However, in order to assess more systematically whether the content of the descriptions was internally consistent in terms of the levels of safety culture, an empirical approach was taken. The aim of the study reported here was to decompose the rich qualitative descriptions generated in the interview study into their constituent statements and use them to develop a questionnaire to investigate workforce perceptions around safety culture. Responses to the questionnaire would allow an assessment of how far the statements formed statistically coherent and distinct groups corresponding to the increasing levels of maturity.

Hale (2000, p. 13) has provided an appropriate statement with which to summarise at this point:

The challenge is to find the tools which allow us to assess effectively whether a given organisation has such a [positive safety] culture, and to help develop it, if it does not. We face also the even greater challenge to demonstrate that this culture is really (the only one which is) favourable to good safety performance. Validation should always be our long term aim.

## 2. Method

Fifty-nine employees participated in the study which took place a refinery and chemicals plant of the petrochemical multinational that had participated in the interview study. Questionnaires were distributed by supervisors responsible for safety to their work groups, and Freepost envelopes were provided for the supervisors to return the completed questionnaires to the researchers at Manchester University. Respondents included both refinery and chemicals plant workers, at a range of job levels, including managers, supervisors and operations staff.

### 2.1. Preparation of the questionnaire

The aim of the study was to assess the coherence of the descriptions of the safety culture levels. In order to do this the descriptions were decomposed into individual statements. Constraints of time and resources made coverage of all the aspects listed in the framework impractical. Therefore seven of the 18 organisational aspects were selected on the basis of their relevance to a wide range of employees within the organisation:

- Commitment level of workforce to HSE and care for colleagues.
- Balance between HSE and profitability.
- Workforce interest in competency and training.
- Work-site job safety techniques.
- Purpose of procedures.
- Repercussion and feedback after accidents.
- Audits and reviews.

The decomposition procedure yielded a set of statements for each one of the seven organisational aspects. The questionnaire developed included these statements, presented in random order in seven sections. Each section comprised the statements corresponding to

<i>Safety culture level</i>	<b>Statement</b>
<i>Pathological</i>	When it comes to safety, individuals look after themselves
	“Who cares about safety as long as we don’t get caught?”
<i>Reactive</i>	Commitment to HSE and care for colleagues diminishes after a period of good safety performance
	After accidents there is a voiced commitment to care for colleagues by both management and workforce
	After accidents there is a voiced commitment to care for colleagues by both management and workforce
	‘Look out for yourself’ is the rule when it comes to safety
<i>Calculative</i>	People know how to pay lip service to safety, but practical components may prevent complete follow through
	There is a trickle down of management’s increasing awareness of the cost of safety failures
<i>Proactive</i>	The feeling of pride in HSE and care for colleagues is not universal
	Pride in HSE is beginning to develop, increasing the workforce’s commitment to HSE and care for colleagues
<i>Generative</i>	Levels of commitment and care are very high and are driven by employees who show passion about living up to their aspirations
	HSE standards are defined by the workforce

Fig. 1. Statements for “Commitment to HSE and care for colleagues”.

one aspect of safety culture. Respondents were required to indicate how far each statement described their place of work, using a 5-point scale, where one represented strong disagreement, and five strong agreement.

Fig. 1 shows the statements relating to one of the aspects: “Commitment to HSE and care for colleagues” and the level of safety culture each represents. The number of statements corresponding to each level of safety culture varied with the length of description generated in the interview study.

### 3. Results

#### 3.1. Data analysis

For each of the seven organisational aspects, the following analytical strategy was followed. Having established, using Bartlett’s test of sphericity (a test of factorability for

samples with fewer than five cases per variable; Tabacknik and Fidell, 1996) that each set of statements was suitable for principal components analysis (PCA), this technique was used to uncover the components underlying perceptions of the organisational safety culture within each organisational aspect. PCA was chosen over exploratory factor analysis (EFA) to provide an empirical summary of the data set (Tabacknik and Fidell, 1996), and also due to the size of the sample which was sufficient for PCA but not EFA (Hair et al., 1990; West, 1990). Each aspect of the organisation was analysed separately, i.e. PCA was applied to the set of statements relevant to each individual aspect. When the components resulting from oblique rotation were inter-correlated at levels of 0.2 or above, this solution was retained. Where the components were not inter-correlated above 0.2, a varimax (orthogonal) rotation was applied to maximise their separation and aid subsequent interpretation.

The statements comprising each component were used to interpret the meaning of components with eigenvalues greater than one. Scales were constructed from the statements that loaded on the components and tested for reliability, using alpha reliability scores, or correlations where only two statements loaded on a component. There were a number of components that included only a single item. If a scale was unreliable, the inter-item correlations were inspected and statements dropped from the scale as indicated. Some items cross-loaded on two components, although none had high loadings on more than one. In these cases, they were assigned to the component on which they had a higher loading.

### 3.2. Organisational aspect 1: Commitment to HSE and care for colleagues

Table 1 shows the component structure and loadings of the PCA of the subset of items that represented Commitment to HSE and care for colleagues. The four components that

Table 1  
PCA structure for Commitment to HSE and care for colleagues

Statement ( <i>Safety culture level</i> )	Component			
	1	2	3	4
The feeling of pride in HSE and care for colleagues is not universal ( <i>Proactive</i> )	.801			
Levels of commitment and care are very high and are driven by employees who show passion about living up to their aspirations ( <i>Generative</i> )	-.709			
Commitment to HSE and care for colleagues diminishes after a period of good safety performance ( <i>Reactive</i> )	.641			
There is a trickle down of management's increasing awareness of the cost of safety failures ( <i>Calculative</i> )	.532		.451	
People know how to pay lip service to safety, but practical components may prevent complete follow through ( <i>Calculative</i> )		.770		
Who cares about safety as long as we don't get caught? ( <i>Pathological</i> )		.694		
Pride in HSE is beginning to develop, increasing the workforce's commitment to HSE and care for colleagues ( <i>Proactive</i> )		-.465		
When it comes to safety, individuals look after themselves ( <i>Pathological</i> )			.695	
HSE standards are defined by the workforce ( <i>Generative</i> )			.669	.417
Look out for yourself is the rule when it comes to safety ( <i>Reactive</i> )		.447	.645	
After accidents there is a voiced commitment to care for colleagues by both management and workforce ( <i>Reactive</i> )				.884

Note: Orthogonal rotation; component loadings <.40 omitted for clarity, KMO = 0.67.

Table 2

Summary of PCA and scale statistics for Commitment to HSE and care for colleagues

Component number and label	Number of items on component	Eigenvalue	Variance explained (by component)%	Cronbach $\alpha$ (for scale)
1 “Lack of commitment”	4	2.82	25.6	.64
2 “Lip service paid to HSE”	3	1.66	15.1	.56
3 “Self-preservation”	3	1.30	11.8	.47
4 “Commitment after an accident”	1	1.06	9.7	n/a

emerged from the data together accounted for 62.2% of the variance. The first component was characterised by the perception that there is a lack of commitment to HSE, and the second by the perception that only lip service is paid to HSE in the organisation. The third component reflected a feeling amongst the workforce that they have to look out for themselves to avoid harm. Only one item loaded on the fourth component in the analysis, which was the belief that there is commitment to HSE after an accident has occurred.

Table 2<sup>1</sup> shows the eigenvalue for each component, the percentage of the total variance it explained and alpha reliability scores for the associated scales. The alpha reliability coefficients for the scales were not strong, but could not be improved by omitting any of the items from these scales.

### 3.3. Organisational aspect 2: Balance between HSE and profitability

As illustrated in Table 3, PCA of the items reflecting the balance between HSE and profitability elicited three inter-correlated components, explaining 56.6% of the total variance. The first component was characterised by the perception that profitability takes priority over safety in the organisation. The second component reflected management belief in HSE, and the third corresponded to organisational commitment to HSE. Table 9, in Appendix A shows summary statistics for the components and scales for this subset of items. The alpha reliability coefficients for the three scales varied from good to satisfactory.

### 3.4. Organisational aspect 3: Workforce interest in competency and training

PCA of the items representing workforce interest in competency and training produced six orthogonal components that explained 72.2% of the total variance (see Table 4). The first component reflected training being seen as an ongoing process in the workplace and the second component represented the importance attached to the assessment of training. Component 3 included two items related to the attitudinal change component of training. Components four and five were less positive, conceptualising training as a reaction to adverse events and as a way of getting time off work respectively. The sixth component was comprised of three items reflecting the notion that training and skills required are identified and proposed by the workforce—a positive aspect of the organisation.

Table 10 in Appendix A shows the summary of the PCA and scale statistics. Where a scale is made up of only two items, the Pearson's correlation coefficient between the two

<sup>1</sup> Summaries of the PCA and scale statistics for each of the other six organisational aspects included in the study are shown in Tables 9–14 in Appendix A.

Table 3  
Wording and component structure for the Balance between HSE and profitability

Statement ( <i>Safety culture level</i> )	Component		
	1	2	3
Cost is important, but there is some investment in preventative maintenance ( <i>Reactive</i> )	-.885		
Safety is seen as costing money, and the only priority is to avoid extra costs ( <i>Pathological</i> )	.649		
Safety is seen as discretionary expenditure ( <i>Calculative</i> )	.646		
If all contractors are unacceptable, the least bad is taken ( <i>Calculative</i> )	.600	.424	
Profitability is the only concern ( <i>Pathological</i> )	.546		-.420
The line spends most of its time on operational issues ( <i>Calculative</i> )	.515		
The company tries to make HSE the top priority, understanding that HSE contributes to financial return ( <i>Proactive</i> )	-.503		
Operational components dominate in the balance between HSE and profitability ( <i>Reactive</i> )	.414		
Line managers know how to say the right things, but do not always walk their own talk ( <i>Calculative</i> )		-.796	
The company is quite good at juggling HSE and profitability but money still counts ( <i>Proactive</i> )		-.702	
Management believe that HSE makes money ( <i>Generative</i> )		.588	
HSE and profitability are in balance, so that this becomes a non-issue ( <i>Generative</i> )			.771
The company accepts delays to get contractors up to standard in terms of safety regardless of cost ( <i>Generative</i> )			.629
Safety and profitability are juggled rather than balanced ( <i>Calculative</i> )		-.402	-.568

Note: Non-orthogonal rotation; component loadings <0.40 omitted for clarity, KMO = 0.82.

items is shown. The reliability of the first two scales was good, and the correlation coefficients for scales three and four were statistically significant. The reliability for scale six was unsatisfactory at 0.42. Inspection of the inter-item correlations suggested that two should be combined to form a new scale for “needs identified by the workforce”, leaving the other item “attendance when legally required” as a single item measure. These items are shown in the lower part of Table 10.

### 3.5. Organisational aspect 4: Work-site job safety techniques

As shown in Table 5, four orthogonal components emerged from PCA of these statements, together explaining 63.9% of the total variance. The first of these reflected the acceptance of safety visits as part of the HSE-MS. The second component related to hazard observation being seen as standard practice and the third to the maintenance of safety management techniques. The fourth component reflected a negative aspect of the organisation, that if there are any safety management techniques they are only bought in (from other organisations) in response to accidents.

Table 11 in Appendix A demonstrates that the reliability coefficient for the first scale was low, but could not be improved by omitting any of the items. The correlation between the two items in scale two was statistically significant. The very poor reliability of scale four resulted in the items being split, and, as none of these were inter-correlated, they were left as single item measures. These items are listed in the lower part of the table in order of size

Table 4  
Wording and component structure for Workforce interest in competency and training

Statement ( <i>Safety culture level</i> )	Component					
	1	2	3	4	5	6
Development is seen as a process rather than an event ( <i>Generative</i> )	.771					
There is some on-the-job transfer of training ( <i>Calculative</i> )	.769					
Competence matrices are available and lots of standard training is given ( <i>Calculative</i> )	.698					
Issues like attitudes have become as important as knowledge and skills ( <i>Generative</i> )	.546		.475			
Leadership fully acknowledges the importance of tested skills on the job ( <i>Proactive</i> )		.782				
Knowledge acquired on training courses is tested ( <i>Calculative</i> )		.673		-.412		
The workforce are an integral part of the training process rather than just passive receivers ( <i>Generative</i> )		.641	.476			
The training effort made after an accident diminishes over time ( <i>Reactive</i> )		-.537		.427	.446	
The workforce is proud to demonstrate their skills in on-the-job assessment ( <i>Proactive</i> )			.768			
Training is aimed at the person—If we change their attitude everything will be alright ( <i>Reactive</i> )			.721			
After an accident money is made available for specific training programs ( <i>Reactive</i> )				.832		
Training is seen as a necessary evil ( <i>Pathological</i> )				.670		
Workers don't mind exchanging a harsh working environment for a couple of hours off the job ( <i>Pathological</i> )					.892	
Training needs are beginning to be identified by the workforce ( <i>Pathological</i> )						.796
Needs are identified and methods of acquiring skills are proposed by the workforce ( <i>Generative</i> )			.477			.550
Training is attended when it is required by law ( <i>Pathological</i> )						-.541

Note: Orthogonal rotation; component loadings <0.40 omitted for clarity, KMO = 0.69.

of their loading on component four. When the items that made up the fourth scale were considered separately, however, there was strong disagreement with the item that represented the notion that individuals have to look out for themselves, and agreement with the other two items. These two items related to commercially available safety techniques being used to manage HSE.

### 3.6. Organisational aspect 5: Purpose of procedures

Table 6 shows the five orthogonal components that emerged from PCA of the items investigating perceptions of the purpose of procedures, and explained 65.5% of the total variance. The first component was characterised by the perception that procedures are a response to adverse events and to avoid litigation and are therefore ill-conceived. The second component represented procedures as communicating best practice in accident

Table 5  
Wording and component structure for Work-site job safety techniques

Statement ( <i>Safety culture level</i> )	Component			
	1	2	3	4
Safety visits are accepted by the workforce as being in their own interest ( <i>Proactive</i> )	.804			
Safety visits, as a work-site hazard management technique, is revised regularly in a defined process ( <i>Generative</i> )	.731			
Quotas are used to check that the job safety techniques required by the management system are working ( <i>Calculative</i> )	.499			
People (both workers and supervisors) are not afraid to tell each other about hazards ( <i>Generative</i> )		.782		
The workforce regards job safety analysis/observation techniques as standard practice ( <i>Proactive</i> )		.682	.483	
There is little systematic use of the standard work-site management technique after its initial introduction ( <i>Reactive</i> )				-.889
There are no techniques applied—"Look out for yourself" ( <i>Pathological</i> )				.762
After accidents a standard work-site hazard management technique is bought in ( <i>Reactive</i> )			.494	.541
A commercially available technique meets the requirements of the management system ( <i>Calculative</i> )		.448		.498

Note: Orthogonal rotation; component loadings <0.40 omitted for clarity, KMO = 0.46.

Table 6  
Wording and component structure for the Purpose of procedures

Statement ( <i>Safety culture level</i> )	Component				
	1	2	3	4	5
Procedures are often written in response to accidents ( <i>Reactive</i> )	.798				
Procedures are seen as limiting people's activities to avoid law suits or harm to assets ( <i>Pathological</i> )	.650		-.423		
HSE procedures are seen as occasionally inconvenient by a competent workforce ( <i>Proactive</i> )	.648				
The overall effect of procedures is not necessarily properly considered in detail ( <i>Reactive</i> )	.578				
HSE procedures spread best practice ( <i>Proactive</i> )		.759			
There are many HSE procedures serving as 'barriers' to prevent incidents ( <i>Calculative</i> )	.411	.680			
There is trust in employees that they can recognise situations where compliance should be challenged ( <i>Generative</i> )		.617			
Non-compliance to HSE procedures goes through recognised channels ( <i>Generative</i> )			.786		
The purpose of HSE procedures is to prevent individual incidents recurring ( <i>Reactive</i> )			.701		
Procedures are refined for efficiency ( <i>Generative</i> )				-.863	
The company makes HSE procedures out of necessity ( <i>Pathological</i> )	.459		-.483	.504	
It is hard to separate procedures from training ( <i>Calculative</i> )					.747
A limited degree of non-compliance is acceptable ( <i>Proactive</i> )		-.465			.579

Note: Orthogonal rotation; component loadings <.40 omitted for clarity, KMO = 0.59.

prevention—the only component representing a positive aspect of procedures to emerge from this subset of items. The third component corresponded to procedures being equated with incident prevention guidelines, the fourth to procedures as a necessary evil and the

Table 7  
Wording and component structure for Repercussions and feedback after accidents

Statement ( <i>Safety culture level</i> )	Component			
	1	2	3	4
The results of accident investigation are fed back to the supervisory level ( <i>Proactive</i> )	-.726			
After an accident the focus is on the employee, and they are often fired ( <i>Pathological</i> )	.699			
Warning letters are sent by management ( <i>Reactive</i> )	.655			
Management is disappointed but asks about the well-being of those involved ( <i>Proactive</i> )	-.568		-.447	
After an accident reports are not passed up the line if it can be avoided ( <i>Reactive</i> )	.547			
The priority is to limit damage and get back to production ( <i>Pathological</i> )	.539		.413	.441
Investigation focuses on underlying causes ( <i>Proactive</i> )		.783		
Top management show personal interest in individuals and the investigation process ( <i>Generative</i> )		.768		
Top management is seen amongst the people involved directly after an accident ( <i>Generative</i> )		.751		
Employees take it personally when others have accidents ( <i>Generative</i> )		.514		
Line management is annoyed by 'stupid' accidents ( <i>Reactive</i> )			.846	
Management goes ballistic when they hear of an accident— "What does this do to our statistics?" ( <i>Calculative</i> )			.773	
The workforce report their own accidents but maintain distance from contractor incidents ( <i>Calculative</i> )				.848

Note: Orthogonal rotation; component loadings <0.40 omitted for clarity, KMO = 0.62.

fifth to the inflexibility of procedures. In [Appendix A, Table 12](#) shows that the reliability and correlation coefficients were satisfactory for the first four scales constructed from the component structure. The two items that loaded on component five were not significantly correlated and were treated as single item measures and are shown in the lower part of the table.

### 3.7. Organisational aspect 6: Repercussion and feedback after accidents

Four orthogonal components emerged from PCA of this subset of items, which explained 61.6% of the total variance (see [Table 7](#)). The first component was characterised by the focus on active failures at the location of the accident, with no feedback to or from higher up the line. Conversely, the second component reflected a focus on the underlying causes and top management being involved, which was the sole component reflecting a positive element of the organisational safety culture. The third component represented a focus on blame and shame, and the fourth the disassociation of the organisation's accidents from those of contractors. As shown in [Table 13](#) in [Appendix A](#), the scales generated from this subset of items had acceptable reliability and correlation coefficients.

### 3.8. Organisational aspect 7: audits and reviews

[Table 8](#) illustrates the five inter-correlated components that emerged from PCA of this data subset, which explained 67.6% of the variance. The first component reflected the

Table 8  
Wording and component structure for Audits and reviews

Statement ( <i>Safety culture level</i> )	Component				
	1	2	3	4	5
There is a full audit system running smoothly with good follow up ( <i>Generative</i> )	-.817				
Audits are mainly financial ( <i>Pathological</i> )	.757				
The company is happy to audit others, but being audited is less welcome ( <i>Calculative</i> )	.753				
There is continuous informal search for non-obvious problems with outside help when needed ( <i>Generative</i> )		.804			
Management and supervisors realise they are biased and welcome outside help with audits ( <i>Proactive</i> )		.633			
Audits are seen as positive, if painful ( <i>Proactive</i> )		.498		-.363	
Being audited is accepted as inescapable, especially after serious or fatal accidents ( <i>Reactive</i> )			.784		
Audits are structured in terms of management systems ( <i>Calculative</i> )			.654		
There is a regular, scheduled audit program that concentrates on known high hazard areas ( <i>Calculative</i> )	-.426		.491		
There is unwilling compliance with statutory inspection requirements ( <i>Pathological</i> )		-.351	-.363		
There are fewer audits of hardware and systems and more at the level of behaviours ( <i>Generative</i> )				.875	
HSE audits are unstructured, and only take place after major accidents ( <i>Pathological</i> )					-.885
There is no schedule for audits and reviews as they are seen as a punishment ( <i>Reactive</i> )					-.611
There is an extensive audit program including cross-auditing within the organisation ( <i>Proactive</i> )					.586

Note: Non-orthogonal rotation; component loadings <0.35 omitted for clarity, KMO = 0.73.

perception that audits are a necessary inconvenience that are not followed up. The second represented audits and reviews as being a positive, if uncomfortable, learning opportunity, and the third corresponded to audits being a part of the HSE-MS. The fourth component reflected the balance between audits of systems and those of behaviours, and the fifth represented audits as structured, regular and widespread within the organisation. Table 14 in Appendix A shows the scales for this subset of items had acceptable reliability coefficients. The coefficient for the third scale was the lowest at 0.57, but could not be improved by removing any of the items.

#### 4. Discussion

The internal consistency of the safety culture descriptions elicited from the original interview study (Parker et al., in press) was mixed. While there was good statistical support for some of the aspects, for others evidence was weak. On the other hand, the way in which the statements grouped together empirically did suggest that, in general, participants not only perceived desirable features of safety culture to be associated with each other, but perceived them as different from undesirable aspects of safety culture.

In the following section, the following two questions are addressed in relation to each of the organisational aspects in turn:

- How did the components compare with the safety culture level descriptions as they had previously been defined?
- Were there any problems with decomposing the statements that made up the descriptions of the safety culture levels?

#### *4.1. Organisational aspect 1: Commitment to HSE and care for colleagues<sup>2</sup>*

Although the four components that emerged were negative in terms of safety culture maturity, the way in which the individual items combined to load on the components was consistent with the Westrum safety culture maturity framework. Some statements loaded negatively e.g. the generative item “Levels of commitment and care are very high ...” in component 1. Others were open to a negative interpretation when considered in isolation from the others comprising the full description of the safety culture maturity level. For example, the generative item “HSE standards are defined by the workforce” was probably interpreted as meaning that the workforce have to look out for themselves, whereas in the context of the original description it carried the positive connotation that the organisation is advanced enough in terms of safety management to allow the workforce to set HSE standards.

The pattern of components emerging also supported the role of commitment to HSE as an aspect of organisational safety culture. Statistically, the clearest grouping of items was around the first component, which described lack of commitment to HSE, followed by components describing paying lip service to safety, the notion of individual self-preservation and the reactive nature of voiced commitment to HSE. These components provided an empirical summary of the employees’ perception of the important elements of this “abstract” (i.e. less tangible and documented) aspect of safety culture.

#### *4.2. Organisational aspect 2: Balance between HSE and profitability*

The items submitted to analysis grouped together empirically in a way that supported their origin in the descriptions of the levels of safety culture maturity. For example, an item representing the proactive level “The company tries to make HSE the top priority ...” had a negative loading on the component deemed to represent profitability taking priority in the organisation. Similarly, with respect to the organisational commitment component, a negatively loaded item corresponding to the calculative level “Safety and profitability are juggled rather than balanced” emerged as part of a component including two generative items. Only one (proactive) item, “The company is quite good at juggling HSE and profitability but money still counts” seemed to have been interpreted in a sense different to that intended. This item loaded negatively on the component representing management belief in HSE. Again it is possible that this occurred because the meaning of the statement altered when it was removed from the context of the other statements making up the overall description.

The three components identified were readily interpretable in terms of the organisational aspect described. The first component that emerged from the analysis was unsurpris-

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<sup>2</sup> Participants’ level of agreement with the items in the questionnaire is not considered in this paper for the sake of brevity and clarity. The organisation in which the study was carried out received a report outlining its safety culture “profile” based on the results of the questionnaire, but that is not the focus of this paper.

ing, in that it represented the general feeling amongst the workforce that profit takes priority in the organisation. It was interesting to note that the component that represented management belief in HSE explained more of the variance than the third component, which corresponded to general organisational commitment. Management belief in HSE was therefore perceived to be more important in terms of the balance between profit and safety in this sample. This finding echoes much previous research where management commitment has been found to be crucial to the safety culture of an organisation (e.g. Mearns et al., 2001; Zohar, 2002).

#### *4.3. Organisational aspect 3: Workforce interest in competency and training*

The six components emerging from these items consisted of combinations of items that supported the descriptions of the safety culture levels from the interview study. One item, taken from the description of the reactive level, “Training is aimed at the person—if we can change their attitude everything will be alright”, loaded on the third component, together with a proactive item, “The workforce is proud to demonstrate their skills in on-the-job assessment”. It appears that, out of context, this reactive item was interpreted as reflecting a positive element of safety culture, perhaps as indicating approval of person-centred training, when in fact the interviewees had intended this item to reflect a focus on fixing the individual rather than the system.

The first two components to emerge from this analysis reflected training as an ongoing process in the workplace and the importance attached to the assessment of training. These were the two clearest components in terms of variance explained and the number of items that loaded onto them, and thus indicated that these competency and training issues were perceived most readily by the workforce. Other training issues emerging were the attitudinal change aspect of training, training being a reaction to undesirable events, training as work avoidance and training needs being identified by the workforce.

#### *4.4. Organisational aspect 4: Work-site job safety techniques*

The four components emerging were all consistent with the safety culture maturity framework in terms of the way in which items loaded on the components. Proactive and generative description items loaded together on the same components, and pathological and reactive description items loaded on other components. The acceptance of safety visits was demonstrated to be a key element of work-site job safety, represented by the clearest grouping of items (component one). Subsequent components corresponded to hazard observation as standard practice, the maintenance of safety management techniques after their initial introduction, and the “buying in” of safety techniques after accidents.

#### *4.5. Organisational aspect 5: Purpose of procedures*

In general, the items relating to the purpose of procedures loaded on the components generated by the PCA in a manner consistent with the description of the levels of safety culture. There were, however, two exceptions. The item “HSE procedures are seen as occasionally inconvenient ...” taken from the description of the proactive safety culture loaded on the component that described procedures as a response to incidents. Respondents may

have interpreted this item as relating to an undesirable feature of safety culture, focusing on the idea that the workforce perceives procedures to be inconvenient. On the other hand, when considered in isolation the reactive item “The purpose of HSE procedures is to prevent individual incidents recurring” appears not to have been interpreted as negative, as it emerged alongside a generative item on the component reflecting procedures as incident prevention guidelines.

The first two components reflected what the workforce perceived as the most coherent groupings of items, the first representing that procedures are a reaction to adverse events, i.e. incidents, to avoid litigation and are therefore ill-conceived. This concurred with work undertaken by the researchers in other parts of the organisation where employees complained that too many procedures were written after accidents. The second component reflected the role of procedures in communicating best practice in accident prevention, which was the actual intention of procedures within the organisation. These two components appear to reflect the advantages and disadvantages of the system, respectively. While procedures were intended as a means to promote best practice, in reality new ones are only written in response to incidents. It was also found during the course of the program of research reported here that once a procedure was developed it would rarely be removed for fear of recrimination or sanctions, should a further incident related to the deleted procedure occur.

#### *4.6. Organisational aspect 6: Repercussion and feedback after accidents*

The items relating to this aspect of the organisational safety culture loaded on to four components very consistently with the descriptions generated in the interview study. The first component consisted of pathological, reactive and negatively loaded proactive items; the second component consisted of proactive and generative items. These two components accounted for ten of the 13 items in this section of the questionnaire. Therefore, the key elements of this aspect of safety culture from the viewpoint of the workforce were the perceptions of a focus on active failures that caused an accident (component one), and of a focus on underlying causes and top management involvement (component two). The remaining components corresponded to a focus on blame after accidents and the disassociation of the operating company’s accidents from those of contractors.

#### *4.7. Organisational aspect 7: Audits and reviews*

The items relating to audits and reviews loaded on the components generated by the PCA in a manner consistent with the descriptions of the levels of safety culture. There were three components that described positive, or desirable, characteristics of safety: audits as a learning opportunity (component two), audits as widespread in the organisation (component five), and audits focusing on behaviours rather than systems and hardware only (component four). The items which loaded on these components were generative and proactive, or negatively loaded reactive and pathological items. The first component described a less advanced safety culture in terms of audits and reviews, specifically that audits are a necessary evil, and consisted of pathological, calculative and negatively loaded generative items. The third component, which had the least clear grouping of items in statistical terms, appeared to describe audits as part of the HSE management system, and consisted of calculative items. This component structure there-

fore provided support for the general framework of proactive, reactive and calculative of safety culture levels.

## 5. Conclusions

Overall, this study provided some support for the 5-level safety culture framework. Some, but not all, of the descriptions of the levels of safety culture elicited in the interview study were found to be statistically reliable when decomposed and submitted to principal components analysis. In general, the items grouped together in ways that did not contradict the 5-level framework. In other words, respondents did not perceive features from the more advanced levels of safety culture (generative and proactive) to be associated with less advanced levels (reactive and pathological). In most cases items representing adjacent stages emerged together on the same factor. When items from stages that are conceptually far apart appeared on the same dimension, one of the items was negatively loaded.

Ideally, this assessment of the reliability of the underlying structure would have been applied to all of the organisational aspects covered in the interviews. However, this would have created a long and complex questionnaire that would have been impractical to administer, with a negligible response rate anticipated. A sample size of approximately 500 participants would have been required to the data associated with such a study to principal components analysis, and regardless of the length of such a questionnaire, there were far fewer than 500 employees at the refinery site. This type of comprehensive validation was not a priority for the sponsoring organisation at the time, despite its value for theory-building research.

There are several possible reasons for the mixed pattern of results observed. First, it may be that the statements included in the questionnaire do not accurately reflect the stages of safety culture that they were designed to. However it is more likely to be the result of breaking down the short descriptions generated in the interview study into their constituent sentences. This had the effect of presenting them to participants in this study out of context. For example, the item ‘the feeling of pride in HSE and care for colleagues is not universal’ was extracted from the description of a proactive safety culture with respect to commitment to HSE. In that description the full wording was as follows: “Pride is beginning to develop, increasing the workforce’s commitment to HSE and their care for colleagues, but the feeling is not universal”. However, taken out of context it is perhaps understandable that respondents took it to mean that commitment was patchy. In this case it is clear that the wording could be interpreted differently as a separate item.

A second possible explanation is that the five stage framework is overly complex as a way of thinking about safety culture in the oil industry. Inspection of the components indicates that most could be interpreted as either reflecting a ‘positive’ or a ‘negative’ safety culture. Those might be the terms in which people working in the industry think when considering safety culture. Moreover, as the oil industry has been working on improving safety for quite a while, pathological organisations may now be almost extinct. On the other hand the generative safety culture represents some kind of ideal state that may seem unrealistic and unattainable to those working in the industry.

Cooper (2000) stated that the creation or enhancement of a safety culture is dependent upon the deliberate manipulation of various organisational characteristics thought to

impact on safety management practices. In outlining the possibility of a theoretically sound model of safety culture, Cooper proposed that research in this field should examine the links between the personal (e.g. values, beliefs, attitudes), behavioural (e.g. competencies, patterns of behaviour) and situational (e.g. organisational systems and sub-systems) characteristics of safety culture. It could be argued that the framework of organisational safety culture levels presented here meets these requirements. It can be used to identify in which of the various organisational aspects of safety culture it would be most effective to focus attempts to improve organisational safety. It also takes into account the personal (individual perceptions), behavioural (what actually gets done at work) and situational (systems in place to manage safety) characteristics of safety culture by covering a wide range of these issues relating to the organisation.

The possible application of the safety culture framework to other industries deserves attention. If the framework can be shown to make sense to organisations in other industries, its theoretical basis will be strengthened by the support for its ecological validity. The safety culture framework has been adapted for use in a healthcare setting, and a preliminary study in this context is currently being undertaken (Kirk et al., submitted for publication).

## Appendix A

Tables 9–14 give the summaries of PCA and scale statistics for organisational aspects 2–7.

Table 9  
Summary of PCA and scale statistics for Balance between HSE and profitability

Component number and label	Number of items on component	Eigenvalue	Variance explained (by component)%	Cronbach $\alpha$ (for scale)
1 “Profit takes priority over safety”	8	5.27	37.6	.83
2 “Management belief in HSE”	3	1.61	11.5	.72
3 “Organisational commitment to HSE”	3	1.05	7.5	.62

Table 10  
Summary of PCA and scale statistics for Competency and training

Component number and label	Number of items on component	Eigenvalue	Variance explained (by component)%	Cronbach’s $\alpha$ /Pearson’s $r$
1 “Ongoing process”	4	4.25	26.6	.79
2 “Importance of assessment”	4	2.22	13.9	.72
3 “Attitude change”	2	1.58	9.9	.33*
4 “Reaction to adverse events”	2	1.40	8.7	.29*
5 “Work avoidance”	1	1.11	6.9	n/a
6 “Needs identified by workforce”	3	1.00	6.3	.42
“Needs identified by workforce”	Items 1 and 9	n/a	n/a	.42**
“Attendance when legally required” <sup>a</sup>	Item 7	n/a	n/a	n/a

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

<sup>a</sup> Negatively loaded on Component 6.

Table 11  
Summary of PCA and scale statistics for Work-site job safety techniques

Component number and label	Number of items on component	Eigenvalue	Variance explained (by component)%	Cronbach $\alpha$ /Pearson's $r$
1 "Safety visits part of HSE-MS"	3	2.20	24.5	.55
2 "Hazard observation as standard"	2	1.25	13.9	.38**
3 "Maintenance of safety techniques"	1	1.20	13.3	n/a
4 "If any techniques, bought in after accidents"	3	1.10	12.3	.28
"Look out for yourself"	Item 5	n/a	n/a	n/a
"Techniques bought in after accident"	Item 2	n/a	n/a	n/a
"Commercial techniques satisfy HSE-MS"	Item 4	n/a	n/a	n/a

\*\*  $p < 0.01$ .

Table 12  
Summary of PCA and scale statistics for Purpose of procedures

Component number and label	Number of items on component	Eigenvalue	Variance explained (by component)%	Cronbach $\alpha$ /Pearson's $r$
1 "Reaction to adverse events"	4	2.76	21.2	.63
2 "Communication of best practice"	3	2.13	16.4	.54
3 "Incident prevention guidelines"	2	1.46	11.2	.29*
4 "Necessary evil"	2	1.14	8.8	.34**
5 "Inflexibility"	2	1.03	7.9	.10 <sup>n/s</sup>
"Procedures and training inseparable"	Item 1	n/a	n/a	n/a
"A limited degree of non-compliance is acceptable"	Item 5	n/a	n/a	n/a

<sup>n/s</sup> Non-significant.

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

Table 13  
Summary of PCA and scale statistics for Repercussion and feedback after accidents

Component number and label	Number of items on component	Eigenvalue	Variance explained (by component)%	Cronbach $\alpha$ /Pearson's $r$
1 "Focus on active failures"	6	3.42	26.3	.73
2 "Focus on underlying causes"	4	1.89	14.6	.70
3 "Blame and shame"	2	1.45	11.1	.43**
4 "Contractors' accidents are separate"	1	1.25	9.6	n/a

\*\*  $p < 0.01$ .

Table 14  
Summary of PCA and scale statistics for Audits and reviews

Component number and label	Number of items on component	Eigenvalue	Variance explained (by component)%	Cronbach $\alpha$
1 "Audits a necessary evil"	3	4.14	29.6	.80
2 "Audits as learning"	3	1.92	13.7	.60
3 "Audits part of HSE-MS"	4	1.38	9.9	.57
4 "System vs. behaviour audits"	1	1.04	7.4	n/a
5 "Audits are widespread"	3	1.00	7.2	.71

## References

- Arboleda, A., Morrow, P.C., Crum, M.R., Shelley, M.C., 2003. Management practices as antecedents of safety culture within the trucking industry: similarities and differences by hierarchical level. *Journal of Safety Research* 34 (2), 189–197.
- Cheyne, A., Oliver, A., Tomas, J.M., Cox, S., 2002. The architecture of employee attitudes to safety in the manufacturing sector. *Personnel Review* 31 (5–6), 649–670.
- Clarke, S., 1999. Perceptions of organizational safety: implications for the development of safety culture. *Journal of Organizational Behaviour* 20, 185–198.
- Clarke, S., 2003. The contemporary workforce—implications for organisational safety culture. *Personnel Review* 32 (1–2), 40–57.
- Cooper, M.D., 2000. Towards a model of safety culture. *Safety Science* 36, 111–136.
- Cox, S., Cox, T., 1996. *Safety, Systems and People*. Butterworth-Heinemann, Oxford.
- Grote, G., Künzler, C., 2000. Diagnosis of safety culture in safety management audits. *Safety Science* 34, 131–150.
- Hair, J.F., Anderson, R.E., Tatham, R.L., 1990. *Multivariate Data Analysis with Readings*, second ed. Macmillan, New York.
- Hale, A.R., 2000. Culture's confusions. *Safety Science* 34, 1–14.
- Hudson, P., 2003. Applying the lessons of high risk industries to health care. *Quality & Safety in Health Care* 12, I7–I12.
- Kirk, S., Parker, D., Claridge, T., Esmail, A., Marshall, M., submitted for publication. The development of a tool to assess patient safety culture in primary care. *Quality and Safety in Health Care*.
- McDonald, N., Corrigan, S., Daly, C., Cromie, S., 2000. Safety management systems and safety culture in aircraft maintenance organisations. *Safety Science* 34, 151–176.
- Mearns, K., Whitaker, S., Flin, R., Gordon, R., O'Connor, P., 2000. Benchmarking human and organisational factors in offshore safety. HSE OTO 2000 036 Report.
- Mearns, K., Flin, R., Gordon, R., Fleming, M., 2001. Human and organisational factors in offshore safety. *Work and Stress* 15 (2), 144–160.
- Mearns, K., Rundmo, T., Gordon, R.F.R., Fleming, M., 2004. Evaluation of psychosocial and organizational factors in offshore safety: a comparative study. *Journal of Risk Research* 7 (5), 545–561.
- Parker, D., Lawrie, M., Hudson, P., in press. A framework for understanding the development of organisational safety culture. *Safety Science*, doi:10.1016/j.ssci.2005.10.004.
- Pidgeon, N.F., 1991. Safety culture and risk management in organizations. *Journal of Cross-cultural Psychology* 22 (1), 129–140.
- Sorensen, J.N., 2002. Safety culture: a survey of the state-of-the-art. *Reliability Engineering & System Safety* 76 (2), 189–204.
- Tabacknik, B.G., Fidell, L.S., 1996. *Using Multivariate Statistics*, third ed. Harper Collins, New York.
- Vredenburg, A.G., 2002. Organizational safety: Which management practices are most effective in reducing employee injury rates? *Journal of Safety Research* 33 (2), 259–276.
- West, R., 1990. *Computing for Psychologists*. Harwood Academic Publishers, London.
- Westrum, R., 1996. Human factors experts beginning to focus on organizational factors in safety. *ICAO Journal* October.
- Zohar, D., 2002. The effects of leadership dimensions, safety climate and assigned priorities on minor injuries in work groups. *Journal of Organizational Behaviour* 23, 75–92.