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Risk-Weighted Safety Culture Profiling

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Abstract

Much organizational effort is directed toward the notion of safety culture, with many being uncertain of what a safety culture is, what is comprises and how to develop one that is 'good'. Making use of theoretical models of safety culture and accident causation a method for 'Risk Weighted Safety Culture Profiling' is presented in the form of a case study The profiling method described provides a common framework for assessing safety culture that [1] Is based on Safety Science; [2] Uses existing methodologies; [3] Facilitates benchmarking within and between industries; and [4] Makes the concept of safety culture more tangible for industry.

1.0 Introduction

A relatively recent phenomenon, the concept of safety culture (INSAG, 1991) has caught the imagination of both academics and practitioners and been described as 'the most important theoretical development in health and safety research in the last decade (Pidgeon, 1991). Safety culture is a short-hand term referring to an organizations 'culture of safety' or those 'cultural influences impacting safety' (Hale, 2000). Debates about the existence of safety culture as a concept are reflected in the multitude of efforts attempting to define safety culture and operationalize it in a meaningful way (e.g. Cooper, 2000; Guldenmond, 2000).

1.1 Past Efforts

To many, the concept of safety culture is simply an expression of attitudes, values and beliefs about safety. This notion is reinforced by the British Health & Safety Commission's (1993) ubiquitous definition of safety culture that focuses on '*invisible*' outcome indicators such as 'mutual trust', 'shared perceptions' and 'confidence in the effectiveness of preventative measures'. This has led to numerous questionnaire studies measuring the 'perceived safety *climate*'. Primarily, these focus on six common themes (but are not limited to):

- Management/ supervisor safety actions (i.e. commitment)
- Safety systems
- Risk perception and self report risk taking
- Work pressures
- Skills and competence of personnel
- Effectiveness of rule and procedures

The reasons for this focus are many and varied, but mostly reside in influential researcher's viewpoints (e.g. Flin, Mearns, O'Connor & Bryden, 2000) which guide the development of subsequent research. This regression to the mean has limited our collective vision of other potentially important influencing factors (e.g. people's personal commitment to safety, human factors, etc.).

Although useful tools to ascertain employees views on the way safety is currently operationalised (Carroll, 1998), many have attempted to statistically link the survey results to lagging indicators such as accident rates (e.g. Lee & Harrison, 2000; Vredenburgh, 2002) via correlations. When a relationship is obtained (often very small), the authors assert they have developed a 'valid' safety culture indicator. There are a number of problems with this approach. Not least is that incident rates are problematic as a valid safety performance measure as they are subjected to under-reporting and the many other types of

'massaging' that takes place in the 'real world'. A further problem is that survey providers seldom take into account pressures exerted on employees to produce positive results by their managers (for example, in fear of losing their jobs and being sent home, many third-party contract nationals working on major multi-national projects indicate everything is great, when plainly they are not). Thus the results of many surveys could be questionable.

From a methodological viewpoint, correlating unreliable, historical incident rates against current (possibly invalid) perceptions is scientifically unsound (i.e. comparing the past with the present). Such factors may explain why statistical links between survey results and accident rates are weak (Clarke, 2006). Nonetheless, the long-held assumption is that safety climate scores accurately reflect safety performance. With the exception of two studies (Cooper & Phillips, 2004; Zohar, 2000), no safety climate survey has yet been found to predict actual safety behavior or ongoing levels of safety performance (defined by loss events). In my view, the collective efforts of the past 25 years have been useful, but have merely highlighted 'what we do not know', rather than building a valid and reliable databank of knowledge about 'what we do know'. This may explain why so few industries use safety climate as a standard, practical ongoing safety performance metric (i.e. a leading indicator). Overall, the poor results from the sole use of questionnaires, suggests that the number of safety culture measurement tools must be much broader, if we are to build a useful, valid and reliable empirical 'safety culture' knowledge base.

2.0 Current Safety Models and Approaches

The one constant in organizational life is change. As such, safety culture is dynamic and always in a state of flux. Recent attempts at modelling safety culture (Cooper, 2000) and subsequent supporting research (Lund and Aarø, 2004) have approached safety culture from three perspectives: psychological, behavioral and structural. These three approaches are triangulated to provide a view of the prevailing safety culture, making use of existing measurement tools / methodologies: [1] safety management system audits, [2] safety climate surveys, and [3] behavioral safety scores. Implicitly or explicitly, most academic definitions of safety culture encompass these three perspectives. Cooper's (2002) business process model of safety culture uses these three approaches to help make a nebulous concept more concrete (see figure 1) for employees and industry: the major stakeholders of safety culture research.

The Business Process Model of Safety Culture illustrates that the 'Inputs' (values, etc., behaviors and organization of the safety management system) are processed by a combination of the company's expectations, goals and management practices and transformed into the safety culture (i.e. Output) to create the safety culture product (i.e. Outcome). The model makes it very clear that it is how a company manages the safety 'inputs" that determines the organizations 'culture of safety'. Supporting evidence for this assertion is contained in Blackspot Construction (HSE, 1988) and other publications that firmly place management at the center of approximately 70 percent of all incidents.

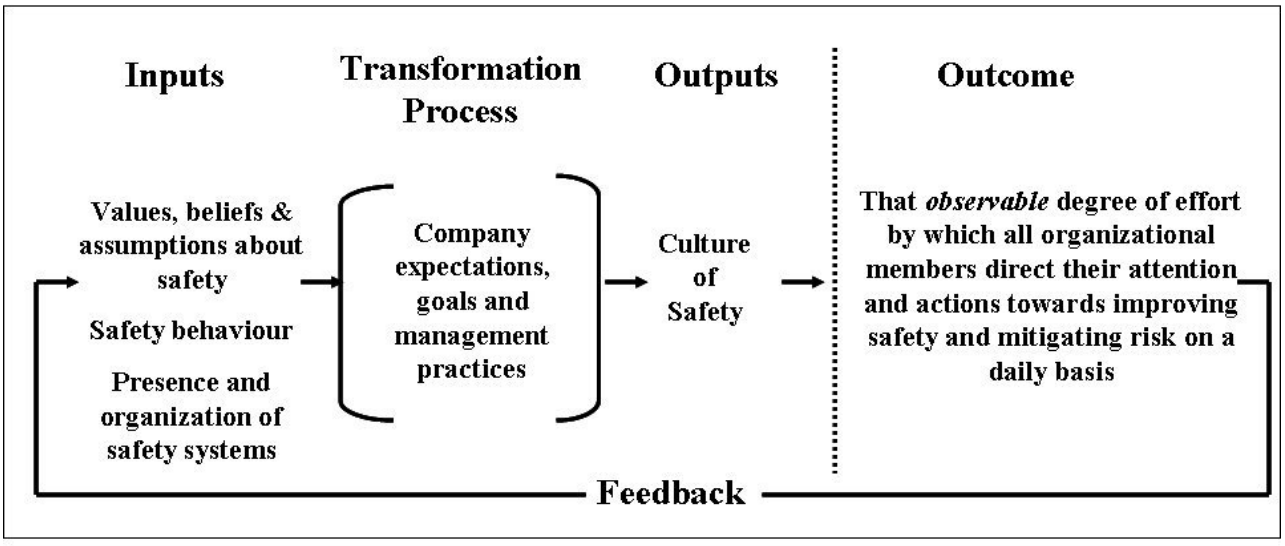

Figure 1: Business Process Model of Safety Culture (Cooper, 2002)

2.1 A framework of measurement and analysis

There appears to be a general consensus that accident aetiology stems from upper management through to lower organizational levels (Pate-Cornell, 1992). This implies that any meaningful measure of safety culture must reflect this reality. The question is how? Based on the earlier work of Heinrich (1931), Weaver (1971) and Adams (1976), Reasons' (1998) 'swiss cheese'

model of defences in depth (see Figure 2) provides the perfect model (e.g. Vincent, Taylor-Adams & Stanhope, 1998) with which to do this as it encompasses all the elements involved in accident causation and investigation. It is relatively simple to apply the model to examining the three elements of safety culture: safety management systems, safety behavior and safety climate. The purpose of this paper is to outline how this is done making use of a case study.

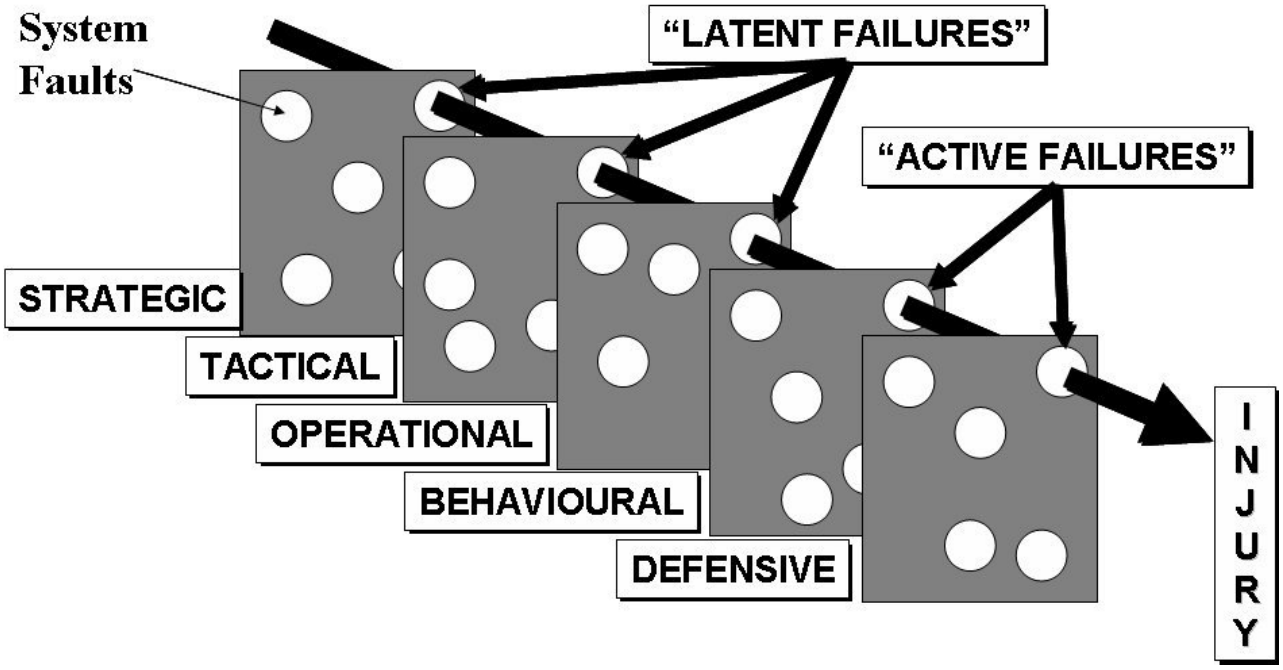

Figure 2: Adaptation of Reason 'Swiss cheese' model

2.2 Risk Assessment

Risk assessment is a fundamental tool in the management of safety (HSE, 1997) that helps companies to evaluate acceptable and unacceptable risks so they can be effectively managed. The management of risk varies across industries according to risk appetite in relation to the industry's production goals. For example, the Oil & Gas industry could not operate without taking calculated risks in terms of exploration and drilling in all weathers, to meet consumer demands. In the safety arena, risk is often defined as the likelihood that a potential hazard will cause harm. Commonly, risk evaluations address the frequency / likelihood of occurrence (i.e. probability) and the severity of impact if a risk is realized (i.e. consequence). Usually, some form of scoring and grading system is used to assert whether a 'potential hazard' represents a high, medium or low risk within a given context. The grade arrived at then dictates subsequent risk mitigation actions. Unfortunately, with few exceptions (e.g. Zimalong & Elke, 2004) there has been a general failure within the academic safety culture community, to make any explicit link of safety culture tools, methods, processes or outcomes to risk. It is relatively simple, however, to link the results of safety management system audits, safety climate surveys, behavioral safety systems and human error analyses to risk indices. The advantage offered is a risk weighted safety culture profile for each of the various organizational levels embedded within the framework provided by Reason's model. More importantly, such risk profiles can be tied to an organization's financial performance by multiplying the risk rating with the estimated financial impact.

2.3 Safety Management Systems

Safety Management Systems (SMS) are integrated organizational mechanisms designed to meet compliance legislation, risks and ongoing performance. Good systems tend to have clearly stated and measurable standards and objectives, monitoring procedures and feedback mechanisms (Cooper, 1998). Broadly speaking, such systems comprise specific sub-elements that cover policy, organizing for safety, planning and implementation, measuring and reviewing performance (e.g. HS(G) 65, ILO 200, BS 8800, OSHA(S) 18001). Importantly, such elements tend to correspond to the organizational levels contained in Reason's framework, particularly within those high hazard industries that have adopted a 'defences in depth' philosophy (See table 1).

Level	SMS Elements
Strategic	Managerial Leadership, Commitment& Accountability
Tactical	Risk Assessment & Risk Management
Operational	Facilities Design & Construction; Personnel & Training
Behavioural	Operations & Third Party Services
Defensive	Policies and Procedures, Information/Documentation; Maintenance; Management of Changes; Incident Investigation & Analysis; Community Awareness & Emergency Preparedness; Operations Integrity Assessment & Improvement.

Table 1: Example Oil & Gas SMS embedded within Reason's (1998) framework

Monitoring tends to take place via audits of particular facets of the management system that can be triggered by the results of incidents, focus group exercises, safety climate surveys, and/or third party certification requirements. Although many types of audit evaluation systems abound, it is a relatively simple procedure to assess the findings for their risk potential and convert the findings of each element into percentage scores to produce 'risk weighted' profiles.

2.4 Safety Behavior

Although, Reason's (1998) model shows us how people's behavior interacts with other levels or functions within an organization, practitioners tend to focus on those safety behaviors exhibited by individuals that cause incidents or harm to that person (commonly referred to as unsafe acts) or property. Behavioral safety systems are one proven method of addressing these (see Grindle et al, 2000 for an excellent review). Unfortunately there has been a tendency for such systems to focus only on the behavior of employees at the 'coalface' (e.g. Hopkins, 2006). It was not generally realized that people's unsafe behavior is determined by failings within the immediate working environment (e.g. lack of PPE or equipment), the current 'climate of safety' within their sphere of operations (e.g. excessive overtime to meet production targets, overloaded maintenance schedules, etc), or organization (e.g. fear of reporting incidents or stopping work on safety grounds). Therefore, little effort has been directed at changing the behavior of those who determine what an organization does (i.e. the executive body), those who develop and run the management systems (i.e. managers), or support the workforce in delivering their product or service (e.g. engineering, human resources, purchasing and supply).

More recent configurations (e.g. Cooper, 2006) addressed the various levels of managerial support, or extended the application to all (Cooper et al., 2005). However, there is still some way to go to fully integrate behavioral safety systems into the overall safety management system. Adopting Reason's 'swiss cheese' framework, Byrom's (2002) classification of risk behavior types (see Table 2) provides a useful framework for developing fully integrated behavioral safety systems. Importantly, the framework also lends itself to 'risk weighted safety culture profiling'.

Level	Behaviour Type	Examples
Strategic	Commitment	Safety Leadership Behaviour
Tactical	Supportive (SMS Systems)	Weekly Managerial Inspections
Operational	Procedural (Risk Control Systems)	Permit To Work
Behavioural	Risk Producing	Lifting incorrectly; Driving too fast
Defensive	Mitigating or Alleviating	Wearing PPE

Table 2: Byrom's (2002) Classification of Risk Behavior Types

2.5 Safety Climate

Safety climate refers to the degree to which employees believe true priority is given to organizational safety performance, and its measurement is thought to provide an early warning of potential safety system failure(s) (Cooper & Phillips, 2004). In most instances, the purpose of measuring safety climate is to provide opportunities for enquiry or change (Carrol, 1998) so as to improve safety performance in the measured organization. As such, the results can provide a useful antidote to current levels of complacency.

Typically a questionnaire is used to measure safety climate, in which respondents are asked indicate their agreement / disagreement with a number of statements (e.g., "In this company, safety is more important than production" or "I take risks to get the job done"). These tend to be scored on 1-5 Likert type scales. Because most surveys are constructed with particular topics in mind, it is relatively simple to adapt such measures to match the organizations safety management system to produce a one-to-one correspondence. This provides the means to cross-check SMS audit results with employee's perceptions (e.g. Hurst, Young, Donald et al. 1996) at each of Reason's five levels. Such methods also facilitate the computation of risk based scores to help produce a risk weighted safety culture profile (i.e. many management systems are risk assessed and these scores can help to risk weight those of the corresponding safety climate perceptions).

2.6 Calculating risk weighted safety culture scores

Calculating risk weighted scores for SMS audits, safety behavior and safety climate scores can be complex due to the different processes involved. To simplify the process requires the use of a common metric across each of the three elements (Cooper, 2002). Percentages are perhaps the easiest to use as they are commonly found in safety management system audits and behavioral safety systems. Safety climate surveys scores using 5 point Likert-type scales can easily be converted into percentages by using the formula in figure 3:

$$\text{\% Safety Climate Score} = \frac{(\bar{X} \times 100)}{500} \times 100$$

Figure 3: Likert-type Scale conversion formula

Percentage scores also facilitate the use of a risk weighted 5 point banding scale which ranges from Alarming (0-50%) to Excellent (91-100%). Percentage scores falling in the 0-50% range could be deemed high risk, on the basis that anything lower than 50% in industrial safety is a high risk with immediate action required for improvement. Those falling in the 51-70% range could be deemed average; those falling in the 71-90% range could be deemed good, both of which would represent a medium risk. However, actions are still required for improvement. Scores falling in the 91-100% range could be deemed excellent and would be graded as representing a much lower risk, with some action required to attain 100%.

3. Case Study

The following case study is used to illustrate how safety culture profiling can be applied in practice. It was conducted within the Oil & Gas industry, located in the Middle East, with the client making extensive use of approximately 2000 third-party nationals plus up to 4500 contractors. The pre-start Total Recordable Incident Rate (TRIR) was 0.78 per 200,000 hours. Some 18 months later, the year to date TRIR was 0.13, representing an 83 percent improvement.

3.1 Method.

Step 1: An internal safety management system audit was conducted on the Eleven SMS elements contained in Table 1 over a three month period by a dedicated audit team. The auditors used 3 assessment criteria: [a] the presence of a system to control risks (i.e. documentation); [b] the levels of compliance to the system; and [c] potential severity of impact of non-compliance. The percentage scores for each criterion were combined to produce an effectiveness score for each of the elements.

Step 2: An independent external company developed a Safety Climate Survey that examined employee's perceptions of [1] Safety leadership; [2] Risk management; [3] Support structures; [4] 'On-the-job' safety behavior; and [5] Corrective actions. These categories broadly correspond with the levels represented in Reason's 'Swiss Cheese' model. The survey was distributed to all employees in 'hard copy'. These were collected by EHS personnel and returned to the provider for analysis. A response rate of 32% was achieved. Mean scores for each category were converted to percentage scores by the author to facilitate safety culture profiling.

Step 3: The author's propriety behavioral safety system was implemented that encompassed plant operations and construction contractors. Specific behavioral issues were identified in three ways: [1] focus group exercises; [2] examining existing incident reports; and [3] examining the results of observation card results. The associated safe behaviors were placed on checklists for 10 site areas and for the contractors. Senior, middle and front-line management 'safety leadership' checklists were also developed. The observation and safety leadership results were entered into online software to compute percentage scores. Corrective actions arising from the observations were also entered into the software and tracked for completion. All data were analysed and used to facilitate corrective feedback at weekly meetings to those concerned. The trends in the observation data were used to adapt the process to suit the particular circumstances (e.g. change the behaviors on the observation checklists, provide tailgate talks on a particular topic, etc).

Step 4: The percentage scores for each assessment method were assigned to their respective organizational levels to produce the organizations risk weighted safety culture profile (see table 3).

Organisational Level	*SMS Effectiveness*	*Employee Perceptions*	*Behavioural Safety*	*Overall Score*	*Risk Level*
Strategic (decision-making body)	79	80	80	*80*	**Medium**
Tactical - Implementation	66	62	87	*72*	**Medium**
Operational – Support functions	82	84	86	*84*	**Medium**
Behavioural – Safety related	94	91	88	*91*	**Low**
Defensive – Risk controls	85	47	40	*57*	**Medium**
Overall	***84***	***73***	***76***	*77*	***Medium***

Table 3: Example Risk Weighted Safety Culture Profile (percentage scores)

Overall, the profile shows that the company's safety efforts still have some way to go to become 'world class'. The safety management systems are in place, but still pose a medium risk to the organization in terms of its effectiveness for day to day risk assessment and management. The employee's perceptions are broadly in line with the results of the SMS audit, but indicate problems at the defensive level related to corrective action implementation. Corrective action tracking scores within the behavioral safety implementation support these perceptions. Although the results are interesting, it is only by developing such a safety culture profile, that it becomes possible to see where an organizations strengths and weaknesses in safety reside, allowing for focused corrective actions.

4.0 Discussion

This paper provides a common practical framework with which to assess and quantify organizational safety culture, taking risk into account. Based on theoretical models of safety that encompass person, job and organizational factors, it does so by making use of existing business tools and processes that has been already validated to varying degrees, and that are already familiar to safety practitioners. Most importantly they can be used to help establish the sustainability of safety cultures across time. If the metrics proposed in this paper were adopted by companies, it should be a relatively simple matter for them to establish a baseline safety culture profile, and then compare it with subsequent profiles across time. In this way, their safety efforts can be assessed for their impact on their safety culture profile. In turn, this will help identify those features that help sustain good safety performance.

Similarly, each element of the model is also a safety improvement tool in its own right. Therefore, any one method is likely to improve safety performance to some degree. Using all three, simultaneously, should exert a much larger impact – i.e. the sum of the whole will be much greater than the sum of the parts. One particular advantage offered from a 'risk weighted' perspective is the tantalizing prospect of being able to empirically research and assert whether a safety culture is 'good' or 'poor' (Pidgeon, 1991). Of course, this would require an assessment of the safety culture scores against a host of safety performance indicators. Ultimately, however, this could result in benchmarking comparisons within and between industrial sectors - a journey well worth embarking upon over the next decade or so.

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