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The nature of safety culture: a review of theory and research

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Abstract

This paper reviews the literature on safety culture and safety climate. The main emphasis is on applied research customary in the social psychological or organisational psychological traditions. Although safety culture and climate are generally acknowledged to be important concepts, not much consensus has been reached on the cause, the content and the consequences of safety culture and climate in the past 20 years. Moreover, there is an overall lack of models specifying either the relationship of both concepts with safety and risk management or with safety performance. In this paper, safety culture and climate will be differentiated according to a general framework based on work by Schein (1992 Schein) on organisational culture. This framework distinguishes three levels at which organisational culture can be studied — basis assumptions, espoused values and artefacts. At the level of espoused values we find attitudes, which are equated with safety climate. The basic assumptions, however, form the core of the culture. It is argued that these basic assumptions do not have to be specifically about safety, although it is considered a good sign if they are. It is concluded that safety climate might be considered an alternative safety performance indicator and that research should focus on its scientific validity. More important, however, is the assessment of an organisation's basic assumptions, since these are assumed to be explanatory to its attitudes. © 2000 Published by Elsevier Science Ltd. All rights reserved.

Keywords: Safety culture; Organisational culture; Safety climate; Safety attitudes; Questionnaire research; Safety performance indicator

1. Introduction

In the last two decades empirical research on safety climate and safety culture has developed considerably but, unfortunately, theory has not been through a similar progression. Although most of the research reported is conducted according to the familiar routines of social scientific — especially social and organisational

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psychological — research, little consensus has been reached on the different aspects commonly associated with a concept within this scientific discipline. For instance, while the importance of the concept of safety climate or culture is stressed by most authors, very few have attempted to support their claim by reporting an indication of its construct validity or predictive validity. Most efforts have not progressed beyond the stage of face validity. Basically, this means that the concept still has not advanced beyond its first developmental stages.

The present paper reviews the research on safety climate and safety culture. It will try to separate out different schools of thought and views. Special attention will be given to the presence of a theoretical model in an approach, because it is thought that such a model, however simple it may be, should be the start of any scientific enterprise. Most of the papers that have been considered for this review are listed in Table 1. While not an exhaustive list, it is thought that it is representative of this research field. Research on culture in general and organisational culture in particular has been of interest not only to social, personnel and organisational psychologists but also to sociologists, anthropologists and political scientists. The main emphasis here, however, is on applied research in the social psychological or organisational psychological traditions. One important assumption associated with these traditions is that a large group of organisational cultures can be described with a limited number of dimensions. Such dimensions are usually sought through large, organisation-wide questionnaire surveys with the ultimate purpose of description or diagnosis and — possibly — intervention. It is acknowledged that this is not the whole story, though. Therefore, some other approaches and views are also discussed.

No review of safety climate or safety culture is complete without a summary of those aspects of the discussion on organisational culture and climate that are relevant for the present review. These aspects will be reviewed first. Next, the different definitions given for safety climate and safety culture are discussed. As will be shown, most authors aim at the same concept but differ on what this concept might encompass, i.e. their operationalisations of the concept differ. As a matter of course this leads to a discussion of the dimensionality of the concept and the causal model underlying it. Unfortunately, not many authors have put forward a theoretical model that can be tested and — ultimately — be falsified. A reflection on the important issue of level of aggregation will round off this part of the review. Thereupon, a framework will be outlined that integrates the review findings.

2. Organisational culture and climate

The concepts of organisational culture and climate gained much attention in the 1970s and 1980s. Clearly, the appeal of such integrative ‘umbrella’ concepts, especially for managers, is great. The prospect of obtaining an overall helicopter view of one’s organisation is indeed attractive. However, because of the fact that these concepts are so global and abstract, they can also run the risk of becoming virtually meaningless.

Table 1
 Overview of the sources, causal models and goals of safety culture and climate researches

Reference	Source	Causal model	Goal
Zohar (1980)	Literature review of characteristics that differentiate between high versus low accident-rate companies	Based on a variety of cues present in their work environment, employees develop coherent sets of perceptions and expectations regarding behaviour-outcome contingencies and behave accordingly	<ol style="list-style-type: none"> 1. Describe a particular type of organizational climate 2. Examine its implications
Glennon (1982a,b)	A review of the organisational climate literature and safety management literature	Organisational climate can be viewed as a bridge between formal organisational characteristics and individual behaviour. [...] The effects of the characteristics are mediated through the perceptions and beliefs of significant individuals and groups among management and employees	Put a handle on the within-company variables that constitute the necessary safety climate in which desired behaviours for hazard reduction and elimination are fostered
Brown and Holmes (1986)	Zohar (1980)	It is acknowledged that no single study can establish causal relationships (“chicken-egg position”)	<ol style="list-style-type: none"> 1. Replicate Zohar’s factor structure 2. Establish valid factor structure 3. Explore differences in climate perceptions between pre- and post-traumatic employees
Lutness (1987)	Self-developed	Not explicitly stated	<ol style="list-style-type: none"> 1. Reveal a safety program’s strengths and weaknesses 2. Find solutions to the problems unearthed 3. Establish benchmarks for a safety program 4. Define safety trends
Cox and Cox (1991)	Framework by Purdham (1984)	Not explicitly stated	Study was set up as the first part of a programme to further develop safety culture as part of one means of improving on the company’s [...] safety culture
Dedobbeleer and Béland (1991)	Brown and Holmes (1986)	Not explicitly stated	Test of Brown and Holmes three-factor model

(continued on next page)

Table 1 (continued)

Reference	Source	Causal model	Goal
Ostrom et al. (1993)	Self-developed	Improve overall level of safety	<ol style="list-style-type: none"> 1. Discussion of the concept of safety culture 2. Presenting a survey instrument developed to assess the safety cultures of organisations 3. Discussing how the results of the survey instrument can be used to improve safety culture
Safety Research Unit (1993)	Facet theoretic approach (a.o. Zohar, 1980)	The climate of an organisation represents the context in which behaviour occurs and the basis of people's expectations; it provides a frame of reference to guide behaviour (cf. Zohar, 1980)	
Cooper and Philips (1994)	Zohar (1980)	Not explicitly stated	<ol style="list-style-type: none"> 1. Replicate Zohar's factorial structure 2. Ascertain if the factor structure is replicated in a post-test 3. Assess any changes in the perceptions of safety climate that may have occurred as a result of a goal-setting and feedback intervention
Niskanen (1994)	Review of safety climate literature	Safety climate provides a link between attributes occurring at the individual (workers and supervisors) level and the organisational level and may be induced by the policies and practices that organisations impose upon their workers and supervisors	<ol style="list-style-type: none"> 1. Develop an approach to safety climate 2. Explore differences in safety climate perceptions 3. Develop new and supplemental perspectives for safety performance
Geller (1994)	Engineering (i.e. equipment design) and psychology (i.e. behavioural and social sciences)	ABC-model (A = Activator, B = Behaviour and C = Consequence)	"A safety professional's ultimate goal is to achieve a total safety culture" (p. 18).

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Table 1 (continued)

Reference	Source	Causal model	Goal
Coyle et al. (1995)	Nominal group technique to determine the relative importance of health and safety issues + Zohar (1980) and Glennon (1982a,b)	As safety climate factors are a representation of the employees' perception of their work environment, their identification indicates those areas where employees feel analysis and/or change may be necessary	Assess whether an analysis of two highly similar organisations would identify the same sets of similar factors
Berends (1996)	Literature review, interviews and clustering of its results	Safety culture shapes the employees' safety behaviour	<ol style="list-style-type: none"> 1. Develop an alternative measure for safety performance 2. Identify strengths and weaknesses 3. Assess effectiveness of safety programmes 4. Assess the opportunities and threats for the implementation of a new safety management tool 5. Reveal differences in perceptions between shop floor workers and management
Lee (1996)	Based on the outcome of discussions of five focus groups	Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perception of the importance of safety and by confidence in the efficacy of preventive measures (cf. ACSNI)	<ol style="list-style-type: none"> 1. To identify those aspects of the safety culture that are in need of improvement 2. To comprehend the underlying order and structure of safety cultures and their dynamic links with other organic variables, such as management style
Cabrera et al. (1997)	Zohar (1980) + additions	Safety climate is considered to produce a "collective schema of meaning", that is thought to have a stronger impact on behaviour than safety policies	<ol style="list-style-type: none"> 1. The development of a series of evaluation measures for training programmes aimed at improving safety levels at airport ramps 2. Evaluate the relationship between safety climate, safety level and safe behaviours 3. Evaluate the influences of various personal and organisational factors on attitude and safety
Williamson et al. (1997)	Literature review for aspects, Cox and Cox (1991) and DeDobbeleer and Béland (1991)	Safety climate is thought to predict the way employees behave with respect to safety in a workplace	To develop a measure of perception and attitudes about safety as an indicator of safety culture for use with working populations

The literature on, as well as the concept of, organisational culture and/or climate has already been reviewed and discussed (e.g. James and Jones, 1974; Schneider, 1975; Glick, 1985; Van Hoewijk, 1988; Schein, 1992). As will become clear, several points emanating from these discussions are equally relevant for the present review of safety culture and climate.

Before defining safety culture and climate, the distinction between culture and climate has to be resolved, i.e. whether it is useful to make such a distinction and if so, why that distinction should be made — or if not, why not.

2.1. Organisational climate versus culture

In the 1970s, much research was undertaken under the title of organisational climate, which naturally also resulted in several debates on the concept (e.g. James and Jones, 1974; Jones and James, 1979; Glick, 1985; De Cock et al., 1986). Gradually, during the 1980s, the term culture replaced the term climate in this type of research. Hence, the development of these concepts has been successive rather than in parallel. Below, a short summary of this development will be given.

Jones and James (1979, p. 205) talk about climate which they describe “as a set of perceptually based, psychological attributes”. To separate climate from job-related attitudes and satisfaction “the *descriptive* and *cognitive* nature of psychological climate” is stressed and contrasted with the affective and evaluative aspects of attitudes. They nevertheless conclude that between the two concepts a “dynamic interrelationship” might be assumed. This distinction between descriptive and affective attributes is brought up by Schneider (1975) in terms of “perceptions of organizational practices” and “reactions to those same practices and procedures” (p. 464) respectively, although he acknowledges that it is quite difficult to distinguish the two.

Ekvall (1983) emphatically distinguishes organisational climate from culture. He divides an organisation’s social system into: (1) organisational culture, i.e. beliefs and values about people, work, the organisation and the community that are shared by most members within the organisation; (2) social structure, i.e. especially the informal organisation; (3) organisational climate; i.e. common characteristics of behaviour and expression of feelings by organisational members; and (4) work relations, i.e. especially the nature of the relationship between management and employees. Ekvall argues that all four segments are mutually related but distinguishable.

Glick (1985) considers the distinction in terms of applied methodology, particularly because the two concepts stem from different disciplines. He argues that research on organisational climate developed primarily from a social psychological framework, while culture is rooted firmly in anthropology. Evidently, both disciplines contribute different research paradigms, the former a more quantitative approach while the latter uses mainly qualitative techniques to study its research objects. Moreover, research on culture is much more focused on the dynamic processes at work in an organisational culture, continuously creating and shaping it. In addition, Glick considers culture research as succeeding climate research. Although

initially distinguishing climate from culture Glick (1985, p. 612) concludes that “[t]he minor substantive differences between culture and climate may prove to be more apparent than real”.

Van Hoewijk (1988, p. 9) describes organisational climate as a term comprising “several correlating views, habits and the atmosphere”, but the concept of organisational culture remains undefined although several convergent and divergent views from various authors are given.

One of the most renowned scholars in the field of, especially national, culture research is Hofstede. He narrows organisational climate down to job satisfaction and to something that is typically the concern of lower and middle management. Organisational culture is considered to be top-management’s business (Hofstede, 1986).

De Cock et al. (1986) attempt to distinguish organisational climate from culture. They argue that organisations are characterised by a coherence of numerous processes. Organisational climate, then, is the perception of this coherence by all the members. On the other hand, organisational culture is the underlying meaning given to this coherence, which forms a pattern of significance and values.

Schein (1992) conceives of climate as preceding culture, i.e. climate is culture in the making. Further on, Schein writes that “climate will be a reflection and manifestation of cultural assumptions” (p. 230). Climate is replaced by culture and culture then conveys a broader and more profound meaning.

So initially, the term organisational climate might have signified the broad construct envisioned by researchers but, successively, it has been restricted to attitudinal or ‘psychological’ phenomena within an organisation, which is how it was initially operationalised. Climate was replaced by the term culture, which nowadays has this comprehensive meaning formerly covered by the term climate.

On the other hand, within the field of safety culture and safety climate research, both terms are still notably in use. Berends (1995a, 1996) considers culture simply a replacement of climate. Other authors, however, restrict themselves to the term safety climate and consider this to be the “psychological” or attitudinal climate with regard to safety within an organisation (e.g. Donald and Canter, 1994; Niskanen, 1994).

For the present the following can be concluded. The term organisational climate was coined to refer to a global, integrating concept underlying most organisational events and processes. Nowadays, this concept is referred to by the term organisational culture whereas the term organisational climate has come to mean more and more the overt manifestation of culture within an organisation. Therefore, climate follows naturally from culture or, put another way, organisational culture expresses itself through organisational climate.

This is also clear from the way in which both concepts are currently operationalised and assessed — assuming of course, that the particular researcher still distinguishes the two. Organisational climate is commonly conceived of as a distinct configuration with limited dimensionality surveyed through self-administered questionnaires. Such measures are, up to a certain point, objective and semi-quantitative. Organisational culture is often determined phenomenologically, i.e. through observations and interviews, through trial-and-error, mutual comparison and the like. Such measures are regarded as qualitative and thus difficult to quantify.

Portrayed this way, organisational climate assessment shows a lot of similarity with attitude measurement. Attitudes are conceptually defined as “a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor”. Within this definition evaluating refers to “all classes of evaluative responding, whether overt or covert, cognitive, affective, or behavioral” (Eagly and Chaiken, 1993, p. 1). An organisational climate, then, would be defined or given by the aggregated attitudes of its members.¹

Among attitude theorists it is commonly assumed that beliefs² are in some sense the building blocks of attitudes (Eagly and Chaiken, 1993). Projecting this assumption on the current discussion of organisational culture and climate, certain strong organisational beliefs could be associated with organisational culture. Or, put in another way, certain beliefs, or better still dogmas or convictions, form the core that is associated with organisational culture.

Similarly, this distinction can be applied to safety culture and safety climate, with the latter denoting attitudes to safety within an organisation and safety culture being the strong convictions or dogmas underlying safety attitudes. These latter beliefs do not have to be specifically about safety, but underlie all organisation’s attitudes.

2.2. Characteristics of organisational culture and climate

Now that culture and climate have been distinguished, the most important findings and the lessons learned from the research on organisational culture and climate are summarised, which are considered relevant for the present review. Organisational culture has been given the following characteristics (needless to say, most of these characteristics equally apply to climate):

1. It is a *construct* (e.g. Guion, 1973; James, 1982; Berends, 1996). Basically this means that culture is an abstract concept rather than a concrete phenomenon. This characteristic already sets the stage for significant disagreement, because it allows the researcher considerable degrees of freedom to both define and operationalise culture. When operationalising a construct, it is generally assumed that there are several variables that covary or fit together to form an unified whole (see also 3).
2. It is relatively *stable*. De Cock et al. (1986) have found a period of stability of at least 5 years for organisational culture.
3. It has *multiple dimensionality* (e.g. Guion, 1973; Jones and James, 1979). Again, this characteristic is the cause of many differences between researchers. Because dimensions are nearly always composites, comprised of several variables, the labelling of a dimension becomes very much a personal matter, reflecting both

¹ Please note that the current conception of attitudes is much broader than, for instance, in the 1970s. At that time, attitudes were considered to be primarily affective, not cognitive. This led Jones and James (1979) to distinguish between cognitive and affective processes and descriptive and evaluative responses as descriptors of organisational climate and job-satisfaction, respectively. Presently, both affective and cognitive processes and responses are considered to underlie attitudes (Eagly and Chaiken, 1993).

² “Mental assent to or acceptance of a proposition, statement, or fact, as true, on the ground of authority or evidence.” (The Shorter Oxford English Dictionary, 3rd edition, 1959).

a common denominator and the researcher looking for it. Clearly, a pre-defined model might guide a researcher here. Additionally, as Jones and James (1979) assert, there might exist both a “central core of dimensions” as well as specific dimensions applying to some particular situation. The extent to which this is true, or that particular cultural manifestations are simply local variants of a central core is still open to investigation.

4. It is something that is *shared* by (groups of) people (e.g. De Cock et al., 1986; Hofstede, 1986; Schein, 1992). Culture is something that is mutual and reciprocal. Consequently, it is *holistic* (e.g. Hofstede, 1991) or refers to *molar* perceptions (Schneider, 1975). Culture is a synergistic aggregate composed of several parts. Some would argue that it is a whole that is more than the sum of its parts. This attribute, however, highlights the fact that not only those constituting parts of culture have to be defined, but also the composition rule which binds them all together (cf. Glick, 1985). Others (e.g. De Cock et al., 1986) consider culture to be an integrative concept, contributing to a helicopter vision that management craves for. This characteristic is the basis for assuming multiple cultures within a large organisation, in that such an organisation can be divided into divisions, departments, units, etc., that will all have developed their own culture. De Cock et al. (1986, p. 6 and 7) mention 6 levels: national culture, corporate culture, organisational culture, departmental culture, group culture and psychological climate. More fundamental, however, is the consideration of distinguishing cultures and making statements about these differences. Again, this characteristic draws attention to the question of what makes up a culture. Schein (1992, p. 14) argues “[...] behavioral regularity should not, therefore, be the basis for defining culture”. And, “when we observe behavioral regularities [at a particular instance], we do not know whether we are dealing with a cultural manifestation”. By making this initial exception for behaviour, Schein wants to prevent “behavioral regularities” elicited by situational characteristics being considered manifestations of culture. The issue of what constitutes a group should not be overlooked. For instance, a common awareness or understanding between a few people cannot be considered a manifestation of a sub-culture. This is also what Schein is aiming at above. With regard to groups Schein stresses the importance of stable membership, common history, shared learning and leadership. This issue will be taken up later, when the topic of aggregation is discussed.
5. It consists of *various aspects*; this means that several, different cultures or climates can be distinguished within an organisation, e.g. a “service climate” (Schneider, 1975), a “creative climate” or “innovative climate” (Ekvall, 1983) or a safety culture. These distinctions have only been made for analytical or practical reasons to narrow the concept and thus make it more tangible.
6. It constitutes *practices*; this characteristic is supplied by Hofstede (1991). He discusses organisational culture primarily in relation to national culture. Hofstede, but other authors as well, conceives cultures as having multiple layers³, not

³ These layers should not be confused with the dimensions mentioned above.

unlike the layers of an onion. At each of these levels, culture has its manifestations which can be studied separately. Hofstede locates norms and values at the central core. His next layer consists of rituals, the following of heroes whilst the outer layer consists of symbols. In considering organisations, only the last three layers- rituals, heroes and symbols — are relevant, according to Hofstede. He calls these three layers “practices” in contrast to the norms and values of the core. These practices are more easily changed than the norms and values, while the more outward a layer is situated, the more superficial it is. Norms and values are learned during childhood through parental upbringing and schooling and remain relatively stable during the rest of our lives. This characteristic also implies that culture is *learned*. However obvious, this fact offers a major justification for contemporary culture research in that it explains the quest for culture’s influences, ingredients and consequences. We wish to influence and change it.

Although authors are relatively consensual about the general ordering of the layers, there is considerable disagreement about what the different layers might encompass (Table 2). Schein (1992) is careful in interpreting the meaning of the outer layers, which is reflected in his phrasing, i.e. *espoused* values and *artefacts*, hereby clearly indicating that what is seen and heard is not always a true expression of culture. Schein is therefore very reluctant to count behaviour as a cultural expression per se. He also removes values from the core, which he replaces with basic assumptions. Hence, what seems to be the core of most authors’ onions is spread over two layers in Schein’s⁴. Any other manifestation of culture is, for him, an artefact, whereas the other authors make several distinctions within those artefacts.

Table 2
Levels of culture

Reference	Central core	Layer 1	Layer 2	Layer 3
Deal and Kennedy (1982)	Values	Heroes	Rites and rituals	Communication network
Hofstede (1986, 1991)	Values	Rituals	Heroes	Symbols
Sanders and Nuijen (1987)	Values and principles	Rituals	Heroes	Symbols
Schein (1992)	Basic underlying assumptions	Espoused values	Artefacts	
Van Hoewijk (1988)	Fixed convictions	Norms and values	Myths, heroes, symbols, stories	Codes of conduct, rituals, procedures

⁴ It is stressed again that Hofstede’s onion is based on his research into national cultures. With regard to the basic assumptions of organisations, the norms and values that distinguish national cultures are obviously far more substantial. I therefore agree with Hofstede that Schein’s basic assumptions are less ‘basic’ than national norms and values. However, I also agree with Schein that within organisations certain beliefs are more pervasive than Hofstede’s practices.

7. It is *functional*; this attribute is discussed by Schneider (1975) but is also implied by Hofstede (1991) and Schein (1992). Culture — probably climate also (Safety Research Unit, 1993) — is functional in the sense that it supplies a frame of reference for behaviour. Schein (1992) considers culture to be the product of adaptive (or external) and integrative (or internal) processes of a group, steered by its leader. A simple and well-known definition of (organisational) culture reads, “The way we do things around here”, which effectively captures this functional aspect.

Overall, organisational culture is a relatively stable, multidimensional, holistic construct shared by (groups of) organisational members that supplies a frame of reference and which gives meaning to and/or is typically revealed in certain practices.

2.3. *The conceptualisation of organisational culture and climate*

Organisational culture and climate are complex concepts. Guion (1973) declares, “[t]he concept of organizational climate is undoubtedly important, but it also seems to be one of the fuzziest concepts to come along in some time” (p. 121). Glick (1985) actually talks about a “conceptual morass” (p. 601) and states that “[organisational] climate is a generic term referring to a class of dimensions that many have argued is so broad and diverse as to make the concept useless” (p. 605). Douglas (cited in De Cock et al., 1986) writes: “Culture is a blank space, a highly respected, empty pigeonhole”. Schein states in the preface of his 1992 book (p. xi): “The concept [of organisational culture] is hard to define, hard to analyze and measure, and hard to manage”. He also mentions the following uses of the term organisational culture (p. 8 ff.): “*observed behavioral regularities when people interact (language, customs and traditions, rituals), group norms, espoused values, formal philosophy, rules of the game, climate, embedded skills, habits of thinking/mental models/linguistic paradigms, shared meanings and “root” metaphors or integrating symbols*”, to illustrate the fact that behind the term culture a lot of different meanings are hiding.

Organisational climate was studied initially as a causal factor influencing job performance and satisfaction (e.g. Friedlander and Margulies, 1969; Payne and Pheysey, 1971) and was established through the measurement of individual perceptions of attributes of that climate. In his “note”, Guion (1973) wonders whether climate actually refers to attributes of organisations or attributes of people. To identify genuinely objective organisational attributes he proposes to present all members with statements about such attributes that can be answered by a simple yes or no. The truly descriptive attributes will all have a very high frequency of endorsement. This confusion about whether organisational climate is an organisational attribute or an individual attribute made James and Jones (1974) suggest a distinction between organisational climate (organisational attribute) and psychological climate (individual attribute).

Dieterly and Schneider (1974) conceive organisational climate as intermediate, “locationary perceptions [...] which help individuals to “fix” or locate themselves in their larger environment prior to behaving” (p. 317). More authors have stressed the

function of organisational climate or culture as a frame of reference for the members of the organisation that directs behaviour (e.g. Schneider, 1975; Safety Research Unit, 1993). Consequently, members' behaviour within the organisation becomes more predictable, which possibly also reduces anxiety (Van Hoewijk, 1988). In like manner, culture functions as a defence mechanism (Schein, 1992) creating both stability and continuity within the organisation (Van Hoewijk, 1988). Accordingly, organisational culture not only functions as a conceptual umbrella but also as a 'real' umbrella, shielding from the precipitation of the unknown or the unwanted.

Overall, researchers do not disagree on the general function of organisational culture or climate as a patterning concept providing a coherent structure to organisational life or certain parts thereof. However, there is no real consensus on how to describe the climate or culture of an organisation, i.e. what is its basic structure, how can it be typified and how should it be determined? This leaves one to wonder why it is so difficult to obtain that consensus.

Firstly, it might be that issues relating to the causes and effects of organisational culture have become intertwined. This relates to the layers of culture mentioned earlier. It is postulated that the core is explanatory for the outer layers. When these layers are confused, one mixes causes with effects, independent variables with dependent.⁵ However, the layered concept of culture introduced above gives the possibility to distinguish climate from culture in terms of these layers. Culture then, would be best associated with the core or Schein's "basic assumptions". The next layer would be culture's primary manifestation or climate.

Secondly, there seems to exist a certain tension between the holistic characteristic of culture and climate and the reductionistic approach of most researchers. Researchers from sociology or a (social) psychological research tradition are inclined to assume that a given culture or climate can be described by a limited number of dimensions. The research objective becomes to uncover that structure, which is usually accomplished by a questionnaire survey. The structure of the culture or climate follows then from analysis of results. Obviously, other approaches are conceivable but also other ways of representing culture. For instance, there is the unresolved debate of whether an organisation *has* a culture or *is* a culture. Furthermore, it is possible to depict culture as a separate entity within an organisation—usually existing beside organisational structure and processes— or as an aspect system, permeating the whole of the organisation (e.g. Frissen, 1986). Moreover, it is of major significance whether one considers organisational culture a collection of — observable — practices (e.g. Hofstede, 1991), a finite set of — conscious — attitudes (e.g. Jones and James, 1979) or a small amount of — unconscious — basic assumptions (e.g. Schein, 1992). Clearly, such diverging views will result in different research questions, paradigms, methods and outcomes.

Thirdly, there is the issue of the level of aggregation. Several authors have tried to shed some light on this aspect of organisational culture (e.g. Guion, 1973; James and Jones, 1974; Jones and James, 1979). It is questioned to what extent individual

⁵ It is acknowledged that this is a rather theoretical distinction which might be hard to substantiate in practice where such relationships are more interactive and dynamic.

measures can be used to say something about organisational levels higher than the individual one. Clearly, this is an issue of great importance because, very often, aggregated individual measures, from questionnaire surveys for instance, are used to say something about the full organisation or certain parts thereof. Or, as Jones and James (1979) state in their study of US Navy enlisted personnel on various ships: “[...] aggregations of such data carry the potential for erroneous inference” (p. 205). Especially so, when “perceptions are combined across groups of increasingly heterogeneous context or structure” (p. 207). Their study enabled them to aggregate their measures — obtained at individual and higher levels — to organisationally meaningful groups or units like ship, division and department. Aggregation to represent ship-wide or departmental-wide conditions did not appear warranted but aggregation to divisional or functional level — like Navigation, Maintenance and Radio Communication — did. Such studies show that seemingly obvious aggregational levels within organisations might not be so homogenous in practice.

Other authors (e.g. Guion, 1973; James, 1982; Glick, 1985) have tried to define criteria for the degree of homogeneity that justifies aggregation. Guion (1973, p. 124) proposes a highly significant amount of agreement or disagreement within the organisation studied on a set of dichotomous questions. Both Glick (1985, p. 607 ff.) and James (1982, p. 221 ff.) propose other indices like η^2 and modifications thereof, which are supplied by one-way analysis of variance (ANOVA) designs. Overall, the level of aggregation and “aggregation bias” (James, 1982, p. 225) are important methodological issues that merit serious attention and that could be the cause of some of the problems encountered in organisational culture and climate research.

Some of these issues will be taken up again when research on safety culture and safety climate is discussed. This discussion will be conducted under the following headings: definition of safety culture and climate, dimensionality of both constructs, models underlying these constructs, level of aggregation and the nature of safety culture.

3. Safety climate and safety culture

The earliest located paper on safety climate is Keenan et al. (1951). This study was based on introspective ratings from primary individuals in an automotive plant. Subsequently, theory and research paradigms have improved but not to the extent that a comprehensive theory on safety culture exists, nor that a measurement approach has been developed that has unanimous preference.

3.1. Definition

Although fairly easily given — usually it is just one line — the definition of a hypothetical construct sets the stage for ensuing research, i.e. it is the basis for hypotheses, research paradigms and interpretations of the findings. It demarcates the boundaries of the concept and focuses the research.

Definitions can be explicit or implicit, the latter leaving much more room for interpretations. Definitions of safety culture and climate are listed in Table 3.

Table 3
Definitions of safety climate and safety culture

Reference	Definition of safety culture/climate
Zohar (1980)	A summary of molar perceptions that employees share about their work environments (safety climate)
Glennon (1982a,b)	Employees' perceptions of the many characteristics of their organisation that have a direct impact upon their behaviour to reduce or eliminate danger (safety climate) and, safety climate is a special kind of organisational climate
Brown and Holmes (1986)	A set of perceptions or beliefs held by an individual and/or group about a particular entity (safety climate)
Lutness (1987)	Not explicitly stated (safety climate)
Cox and Cox (1991)	Safety cultures reflect the attitudes, beliefs, perceptions, and values that employees share in relation to safety (safety culture)
Dedobbeleer and Béland (1991)	Molar perceptions people have of their work settings (safety climate)
International Safety Advisory Group (1991)	Safety culture is that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance (safety culture)
Pidgeon (1991)	The set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimising the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious (safety culture)
Ostrom et al. (1993)	The concept that the organisation's beliefs and attitudes, manifested in actions, policies, and procedures, affect its safety performance (safety culture)
Safety Research Unit (1993)	Not explicitly stated (safety climate)
Cooper and Philips (1994)	Safety climate is concerned with the shared perceptions and beliefs that workers hold regarding safety in their work place (safety climate)
Geller (1994)	In a total safety culture (TSC), everyone feels responsible for safety and pursues it on a daily basis (safety culture)
Niskanen (1994)	Safety climate refers to a set of attributes that can be perceived about particular work organisations and which may be induced by the policies and practices that those organisations impose upon their workers and supervisors (safety climate)
Coyle et al. (1995)	The objective measurement of attitudes and perceptions toward occupational health and safety issues (safety climate)
Berends (1996)	The collective mental programming towards safety of a group of organisation members (safety culture)
Lee (1996)	The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, and organisation's health and safety management (safety culture)

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Table 3 (continued)

Reference	Definition of safety culture/climate
Cabrera et al. (1997)	The shared perceptions of organisational members about their work environment and, more precisely, about their organisational safety policies (safety climate)
Williamson et al. (1997)	Safety climate is a summary concept describing the safety ethic in an organisation or workplace which is reflected in employees' beliefs about safety (safety climate)

Most definitions are very global and therefore highly implicit. The ACSNI (1993) definition — employed by Lee — is the most explicit, outlining most of the assumed contents of safety culture. Of the 16 definitions given in Table 3, nine are about safety climate and seven about safety culture. Nine mention organisation member's perceptions whereas six definitions (also) refer to beliefs and six (also) to attitudes. Five of these are about safety culture. Roughly, perceptions are more associated with climate whereas attitudes are considered to be a part of culture.

The holistic as well as the shared aspect of culture and climate are stressed in most definitions with terms like “molar” (Zohar, 1980; DeDobbeleer and Béland, 1991), “shared” (Cox and Cox, 1991; Cooper and Philips, 1994; Cabrera et al., 1997), “summary” (Williamson et al., 1997), “group” (Brown and Holmes, 1986; Berends, 1995a,b, 1996; Lee, 1996), “set” (Pidgeon, 1991, 1997, 1998), “assembly” (International Safety Advisory Group, 1991), “employees' perceptions” or “organisation's beliefs and attitudes” (Glennon, 1982a,b; Ostram et al., 1993).

The object of these perceptions, beliefs or attitudes are often identified with “work environments” (Zohar, 1980; DeDobbeleer and Béland; Cabrera et al., 1997) or simply specified with “safety” (Cox and Cox, 1991; Cooper and Phillips, 1994; Berends, 1995a,b, 1996; Coyle et al., 1995; Williamson et al., 1997). Sometimes also, these objects are more complex like “organisational characteristics” (Glennon, 1982a,b), “actions, policies, and procedures” (Ostrom et al., 1993) or, equivalently, “organisational safety policies” (Cabrera et al., 1997) or even more abstract like “entity” (Brown and Holmes, 1986) or “attributes” (Niskanen, 1994).

The characteristics “construct” and “dimensionality” of culture and climate described in Section 2.2 are either implicit (Cox and Cox, 1991; Ostrom et al., 1993; Cooper and Philips, 1994; Coyle et al., 1995; Williamson et al., 1997) or explicit (Glennon, 1982a,b; Brown and Holmes, 1986; Niskanen, 1994; Lee, 1996) in most definitions.

The effect of climate or culture on the organisation and its members is sometimes stated as well (Glennon, 1982a,b; Ostrom et al., 1993; Cooper and Philips, 1994; Geller, 1994; Pidgeon, 1991, 1997; Lee, 1996).

To the extent that the particular definition has focused research, Table 1 might yield an answer. Under the heading “Goal” in Table 1 the goals defined explicitly by the researchers are summarised. Most researchers have formulated quite practical goals, although the objectives of some (Brown and Holmes, 1986; DeDobbeleer and Béland, 1991; Niskanen, 1994; Coyle et al., 1995) also have a more theoretical flavour, which might betray the absence of a particular assignment from a company. Hence, most researchers have executed their research with regard to certain questions

Table 4
Overview of the amount of questions, surveyed population and dimensions of safety culture and climate researches

Reference	No. of questions/instrument	Population	Type of analysis	Climate/culture dimensions
Zohar (1980)	40, questionnaire is administered during interview	20 Israelian industrial organisations (steel, food processing, chemical and textile industry); 400 respondents	Exploratory	<ul style="list-style-type: none"> - Importance of safety training programmes - Management attitudes towards safety - Effects of safe conduct on promotion - Level of risk at work place - Effects of required work pace on safety - Status of safety officer - Effects of safe conduct on social status - Status of safety committee
Glennon (1982a,b)	68, self-administered questionnaire (SAQ)	Line managers from eight Australian companies (bauxite, mining, sawmilling and logging metal refining, petroleum refining, cement manufacture and general engineering and manufacturing); 198 respondents	No formal testing	<ul style="list-style-type: none"> - Perceived influence of safety and health legislation - Perceived corporate attitude to safety and health - Perceived organizational status of safety advisory officer - Perceived importance of safety and health training - Perceived effectiveness of encouragement (vs. discipline) in promoting safety - Perceived effect of departmental/section safety record on promotion - Perceived risk level of workplaces - Perceived status of safety targets relative to production pressures
Brown and Holmes (1986)	40, SAQ	10 American manufacturing and produce companies; 425 respondents	Confirmatory	<ul style="list-style-type: none"> - Employee perception of how concerned management is with their well-being - Employee perception of how active management is in responding to this concern - Employee physical risk perception

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Table 4 (continued)

Reference	No. of questions/instrument	Population	Type of analysis	Climate/culture dimensions
Cox and Cox (1991)	18 (+ 4), SAQ	Employees of an European company involved in the production and distribution of industrial gasses; 630 respondents	Exploratory	<ul style="list-style-type: none"> - Personal scepticism - Individual responsibility - Safeness of work environment - Effectiveness of arrangements for safety - Personal immunity
DeDobbeleer and Béland (1991)	9, SAQ	9 construction sites; 272 respondents	Confirmatory	<ul style="list-style-type: none"> - Management's commitment to safety - Worker's involvement in safety
Ostrom et al. (1993)	88, SAQ	Employees of the Department of Energy in Idaho and its eight contractors; ± 4000 administered	No formal testing	<ul style="list-style-type: none"> - Safety awareness - Teamwork - Pride and commitment - Excellence - Honesty - Communications - Leadership and supervision - Innovation - Training - Customer relations - Procedure compliance - Safety effectiveness - Facilities
Safety Research Unit (1993)	65, SAQ	Workers from steel and chemical industries; a total of 1475 respondents	Exploratory	<ul style="list-style-type: none"> - Management/supervisor satisfaction (M1) - Management/supervisor knowledge (M2) - Management/supervisor encouragement and support (M3) - Management/supervisor enforcement (M4) - Personal management contact (M5) - Management support: meetings (M6) - Shopfloor satisfaction (A) - Shopfloor environment: hardware (B) - Work group support/encouragement (C) - Shopfloor training (D)

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Table 4 (continued)

Reference	No. of questions/instrument	Population	Type of analysis	Climate/culture dimensions
Cooper and Philips (1994)	50, SAQ	Personnel of a packaging production plant; 374 (pre) and 187 (post) respondents	Exploratory	<ul style="list-style-type: none"> - Global self safety (E) - Meetings (F) - Safe working procedures (G) - Safety information (H) - Safety representatives: practice (SR1) - Safety representatives: authority (SR2) - Management attitudes towards safety - Perceived level of risk - Effects of work pace - Management actions towards safety - Status of safety officer and committee - Importance of safety training - Social status of safety and promotion
Niskanen (1994)	22 (workers) and 21 (supervisors), SAQ	Workers and management in maintenance, construction and central repair shops; 1890 (workers) and 562 (supervisors) respondents	Exploratory	<p>Workers:</p> <ul style="list-style-type: none"> - Attitude towards safety in the organisation - Changes in work demands - Appreciation of the work - Safety as part of productive work <p>Supervisors:</p> <ul style="list-style-type: none"> - Changes in job demands - Attitude towards safety within the organisation - Value of the work - Safety as part of productive work
Geller (1994)	–	–	–	<ul style="list-style-type: none"> - Person i.e. knowledge, skills, abilities, intelligence, motives, personality - Behaviour i.e. complying, coaching, recognising, communicating, demonstrating actively caring - Environment i.e. equipment, tools, machines, housekeeping, heat/cold, engineering

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Table 4 (continued)

Reference	No. of questions/instrument	Population	Type of analysis	Climate/culture dimensions
Coyle et al. (1995)	30 (organisation 1) and 32 (organisation 2)	Workforce of two organisations “involved in the provision of health care and social services to the elderly” (incl. office, nursing and social work duties); 340 (org. 1), 540 (org. 2) respondents	Exploratory	Organisation 1: - Maintenance and management issues - Company policy - Accountability - Training and management issues - Work environment - Policy/procedures - Personal authority Organisation 2: - Work environment - Personal authority - Training and enforcement of policy - <i>Confidence</i> in the arrangements for safety - <i>Compliance</i> with safe working practices - Perceived <i>priority</i> given to safety - Own <i>active effort</i> put in safety matters - <i>Communication</i> about safety
Berends (1996)	34, SAQ	Three industrial organisations (two chemical process industries and one steel company); a total of 434 respondents	Exploratory	Safety procedures: - Confidence in the safety procedures - Safety rules: - Personal understanding of safety rules - Perceived clarity of safety rules - Permit to work system: - Confidence in effectiveness of PTW - General support for PTW - Perceived need for PTW Risks: - Personal caution over risks - Perceived level of risk at work - Perceived control of risks in the plant - Personal interest in job - Job satisfaction:
Lee (1996)	172, SAQ	Employees at British nuclear industry site; 5295 respondents	Exploratory	Safety procedures: - Confidence in the safety procedures - Safety rules: - Personal understanding of safety rules - Perceived clarity of safety rules - Permit to work system: - Confidence in effectiveness of PTW - General support for PTW - Perceived need for PTW Risks: - Personal caution over risks - Perceived level of risk at work - Perceived control of risks in the plant - Personal interest in job - Job satisfaction:

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Table 4 (continued)

Reference	No. of questions/instrument	Population	Type of analysis	Climate/culture dimensions
Cabrera et al. (1997)	69, SAQ	Employees of several companies at three European airports (ground handling divisions from four airlines, one fuel company, two airport authorities); totalling 389 respondents	Exploratory	<ul style="list-style-type: none"> - Contentment with job - Satisfaction with work relationships - Satisfaction with rewards for good work Participation/ownership: <ul style="list-style-type: none"> - Self-participation in safety procedures - Perceived source of safety suggestions - Perceived source of safety actions - Perceived personal control over safety Design: <ul style="list-style-type: none"> - Satisfaction with design of plant - Training: <ul style="list-style-type: none"> - Satisfaction with training Selection: - Satisfaction with staff suitability - Organisational emphasis on safety - Communication channel about safety - Safety level perceived on the job - Feedback performance on safety
Williamson et al. (1997)	67, SAQ	7 workplaces, covering heavy and light industry and outdoor workers, totalling 660 responses	Exploratory	<ul style="list-style-type: none"> - Specific strategies of accident prevention - Personal motivation for safety - Positive safety – Practice - Risk justification – Fatalism - Optimism

posed to them by one, or more, companies or institutions, which has given their research a particular focus, e.g. implications of some safety climate or culture (Zohar, 1980; Safety Research Unit, 1993; Carbrera et al., 1997; Lee, 1996) indicator of safety climate or culture (Ostrom et al., 1993; Niskanen, 1994; Berends, 199a,b,1996; Williamson et al., 1997) or development of a method for improvement (Glennon, 1982a,b; Lutness, 1987; Cox and Cox, 1991; Ostrom et al., 1993; Cooper and Philips, 1994; Lee, 1996). None of the researchers, however, seems to have a pre-defined target population in mind. In Table 4 the surveyed populations are enumerated; as can be seen from Table 4 both homogeneous and heterogeneous populations with various types of occupations are used in these studies.

In summary, most researchers have defined either safety climate or safety culture in their publications as well as why they want to explore it. These definitions contain some or most of the characteristics defined earlier. The purpose of these studies is often quite practical, although theoretical motives are also put forward. The accent on either perceptions, beliefs or attitudes as well as one or another aggregate (e.g. “molar”, “group”, “summary”) suggests a self-administered questionnaire research paradigm. Table 4 shows that this is by far the most common approach. Ludborz (1995) and Kennedy (1997) have opted for alternative approaches, i.e. an audit and a SCHAZOP (Safety Culture HAZOP), respectively. These latter approaches are discussed below.

This particular operationalisation, i.e. a self-administered questionnaire, generally follows a characteristic path of development. First, one demarcates the particular area of interest, which is then thoroughly investigated, mostly through a literature survey. This usually results in the identification of aspects relevant for the area of interest. Given the fact that most researchers focus on beliefs, perceptions and attitudes, these relevant aspects are then the objects of those mental processes. With regard to these aspects, questions are formulated, which are then pre-tested in a pilot study on a relevant population. If the pilot study goes satisfactorily, the questionnaire can be distributed among the target population. The results of this survey are then subjected to certain standard analysis methods like factor analysis (FA) or principal components analysis (PCA) (Tatsuoka and Lohnes, 1988; Tabachnick and Fidell, 1989), where linear relations between the questions or variables are assumed, or techniques like HOMALS or PRINCALS (Van de Geer, 1993a,b), where such linearity is not assumed. These analyses result in factors, principal components or dimensions, which are the subject of the next section.

As can be garnered from the column labelled “Source” in Table 1, this is the approach followed by most researchers, i.e. many start the whole process from scratch again, although the 1980 Zohar study has inspired some researchers in more (Brown and Holmes, 1986; Cooper and Philips, 1994) or less profound ways (DeDobbeleer and Béland, 1991; Safety Research Unit, 1993; Coyle et al., 1995; Cabrera et al., 1997; Williamson et al., 1997). The results of these and more investigations are reviewed next.

3.2. Dimensionality

Commonly, social scientific constructs are multi-dimensional. For instance, a construct like intelligence might not only show in the performance on particular

arithmetic tests but also on visuo-spatial tasks or on certain language exercises. The range of activities which are shown to be influenced might even become so large that the construct is subdivided into separate types like arithmetic intelligence or social intelligence. This is not only true for social scientific artefacts, but applies to the physical world as well. For instance, any object's colour can be described along the three dimensions of the primary colours red, yellow and blue.

Culture and climate have been characterised above as multi-dimensional. Analysis techniques such as FA, PCA, PRINCALS and HOMALS produce such dimensions when they are used for analysing survey results. These dimensions are the result of inter- and intra-respondent tendencies to evaluate certain questions in a similar way. Such tendencies are called correlations, i.e. when two questions are answered overall in a similar way, it is said that these questions correlate. It is assumed then, that these questions have a certain relationship, for instance because they refer to a similar object. This relationship might be obvious but this does not have to be the case. For instance, Hofstede performed a secondary data analysis on information collected among employees at IBM, originally collected to determine their attitudes (Hofstede, 1991, p. 251). With these data, however, he was able to produce his famous 4-D model. And Schuman and Presser (1981, p. 153 ff.) describe a correlation between evaluations of economic policy and a non-existing law, which they can only explain with an overall (lack of) confidence expressed in the government.

In Table 4 results from the analyses performed on the survey results are summarised. At first sight, there is not much correspondence between the researches reported. For one, this is because the researcher has considerable freedom to label her or his dimensions. Obviously, most researchers did not have the need to connect to previous research in terms of their dimensions⁶. Moreover, the number of dimensions found differs enormously. These range from two (DeDobbeleer and Béland, 1991) to 16 (Safety Research Unit, 1993) or even 19 (Lee, 1996, when taken literally).

Although this latter finding might seem striking, a few explanations can be put forward to explain these results. As can be seen from Table 4 the surveys were carried out in different organisations, ranging from industry (Zohar, 1980; Glennon, 1982a,b; Brown and Holmes, 1986; Cox and Cox, 1991; Safety Research Unit, 1993; Cooper and Philips, 1994; Berends, 1995a,b,1996; Williamson et al., 1997) to construction (DeDobbeleer and Béland, 1991; Niskanen, 1994) to energy (Ostrom et al., 1993; Lee, 1996) to airports (Cabrera et al., 1997) and to health care and service (Coyle et al., 1995). Obviously, employees within these organisations have quite different objects for their attitudes. Additionally, what is distinguished by some is considered similar by others⁷, obviously resulting in less complex attitude structures, i.e. fewer dimensions (Eagly and Chaiken, 1993, p. 89 ff.). Cox and Flin (1998) argue that instruments developed in one domain (oil) may not generalise to others

⁶ Interestingly, most studies reviewed here are exploratory. Only the research reported by Brown and Holmes (1986) and DeDobbeleer and Béland (1991) are confirmatory studies (Table 4). Both studies failed to confirm factor structures that had been found previously

⁷ For instance, at the shop floor "management" might be everybody in the office building whereas in the offices people might have a more nuanced view of "management".

(construction). Interestingly, even an attempt aimed at replicating a previously found factor structure in a similar kind of organisation failed (Coyle et al., 1995).

However, additional methodological issues might be important here. For instance, the techniques commonly used — FA or PCA (Tatsuoka and Lohnes, 1988; Tabachnick and Fidell, 1989) — are never questioned for their applicability. The appropriateness of FA or PCA could be questioned with regard to the assumed measurement level of the data. Although for questionnaire data an interval level of measurement is usually assumed, this assumption might not be appropriate and could result theoretically in dimensions which are not actually there. Only the Safety Research Unit applies a different technique called Smallest Space Analysis (SSA; Guttman, 1968). Although this technique uses a mathematical transformation comparable to the other techniques — namely singular value decomposition or SVD (Green and Carroll, 1978) — the final approach is quite different. Hence, the dimensions of the Safety Research Unit in Table 4 are not dimensions in the sense that the others are, they are more appropriately referred to as scales, to avoid confusion.

When a FA or PCA has been performed, the final solution is often rotated to facilitate interpretation (e.g. Tabachnick and Fidell, 1989). This rotation is nearly always orthogonal, meaning that the initial solution of uncorrelated dimensions is preserved. However, this does not have to be the case; the attitude objects reflected in the dimensions might be unrelated in the analysis but do not have to be so in reality. It should be pointed out that the methodological points made above, are mere theoretical considerations. However, in most of the papers reviewed the methodological argumentation — if it is discussed at all — is not particularly strong, which is why these considerations are made here.

There is another interesting discussion related to the issue of methodology. Research by Kerlinger (cited in Eagly and Chaiken, 1993) has shown that certain dimensions are not bipolar but unipolar. For instance a dimension like “political orientation” does not have “conservatism” and “liberalism” at its outer poles but is instead split into two dimensions, one denoting “conservatism” and the other “liberalism”. Kerlinger found that conservatives are not so much opposed to the ideals of liberalism but rather indifferent to these ideals (Eagly and Chaiken, 1993, p. 98). This important distinction has been observed by others as well (e.g. Van Schuur and Kiers, 1994).

In addition, the level of aggregation might play an important part here too. De Cock et al. (1986) argue that the organisational level at which the study is directed and about which statements will be made should be consistent with the instructions and the questioning. With regard to the studies reviewed it is not clear whether this is always the case. The level of aggregation will be discussed later in Section 3.4.

Despite these methodological considerations, a renaming and grouping exercise might yield some solace as well. That is, one could define a small set of common denominators to classify comparable dimensions under. For instance, all dimensions reflecting safety efforts of management could be classified as Management’s Safety Activity. Clearly, when the dimensions found in safety culture and climate research are renamed according to this common classification system, the total amount of dimensions will reduce significantly. Moreover, when the number of times a dimension is found is also taken into account, it will become obvious that certain dimensions

are mentioned more often than others are. Such an index might serve as an indication of importance or ubiquitousness.

In summary, a lot of different dimensions have been found to underlie safety culture and climate. Some methodological arguments have been supplied to explain this abundance and to suggest alternative methodological approaches for application in future research on safety culture and climate. In addition, when many of these dimensions are relabelled their number is significantly reduced and may also yield some insight into the relative importance or ubiquitousness of these dimensions. Additional research and/or secondary data analysis is needed to substantiate these methodological issues and to shed more light on their significance, their consequences and possible solutions.

Deciding on the number of dimensions and their labelling is often facilitated when a model has been used to prepare the questions. The next section reviews the models used for safety culture and climate.

3.3. Causal model

The element missing in many publications on safety culture is an explicit, theoretical model outlining the manner in which safety culture is thought to be embedded in the whole of an organisation's practices and system structure; Table 1 reveals this under the heading "Causal model". Ideally, this model should be about the *cause*, the *content* and the *consequence* of safety culture or climate.

In general, it is possible to distinguish two types of models: (1) normative or prescriptive models, which seek to describe and specify safety climate or culture per se; and (2) descriptive or empirical models, which attempt to summarise findings from one or several organisations studied.

The first actual model of safety climate functioning was put forward by Glennon (1982a,b). In effect, this normative model outlines the cause, content and consequences of safety climate, although in a very global way (Fig. 1).

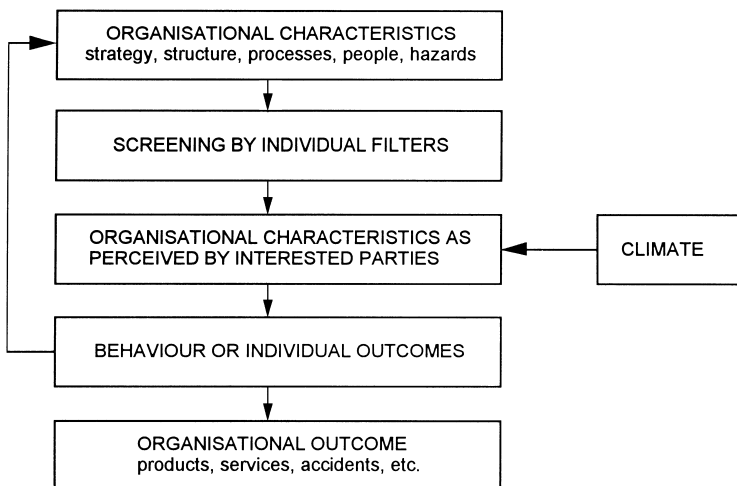


Fig. 1. Glennon's (1982a,b) model of organisational climate functioning.

Glennon operationalises safety climate as the perception of organisational reality, which seems to suggest a kind of attitude measurement, but only partly because perceptions are not identical with attitudes.

Cox and Cox (1991) based their model on work done by Purdham (1984; cited in Cox and Cox, 1991). This model (Fig. 2) appears to be descriptive and the accompanying factor structure is given in Table 4. In this study, safety culture is primarily discussed in the context of attitudes towards safety and their objects, i.e. what has been defined as safety climate above. The model distinguishes several attitude objects — hardware, software, people/liveware and risks. The attitudes towards hardware and physical hazards though, were not incorporated in their study and it is also not clear how it is thought that they affect the other attitudes.

Cox and Cox’s model is not worked out well, but the idea seems to be that the major attitudes to safety within an organisation are directed at four categories of objects:

1. hardware, i.e. safety hardware and physical hazards;
2. software, i.e. rules and procedures, legislation, safety management and policy;
3. people/liveware, i.e. all classes of people involved like workers, supervisors, management, safety committees, specialists, authorities, unions; and
4. risks, i.e. risky behaviour and its regulation.

When talking about attitudes to safety, the objects of these attitudes could always be classified within one of these four major categories.

The model underlying the approach taken by the Safety Research Unit (1993) is established in the “mapping sentence”. The mapping sentence contains all the aspects or “facets” considered relevant for the issue under study (see Shye et al., 1994, for details on facet theory). Consequently, the starting point of facet theory is

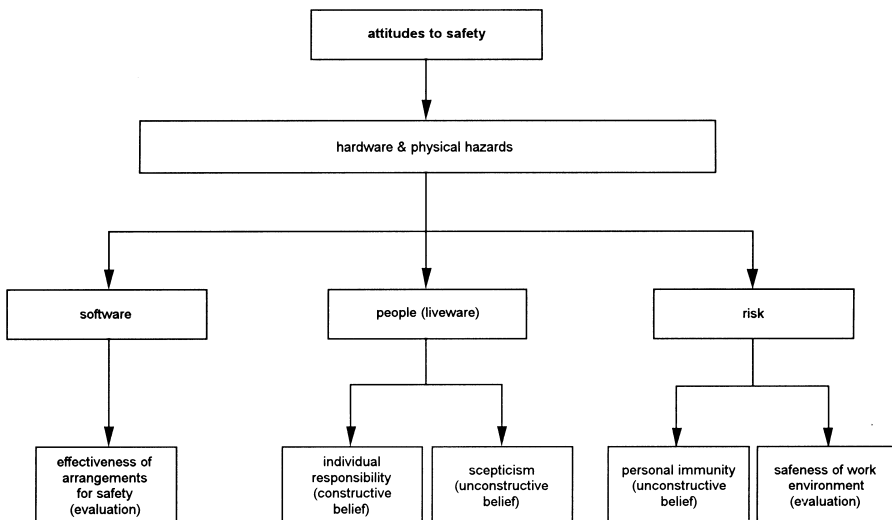


Fig. 2. Cox and Cox’s (1991) suggested architecture of attitudes towards safety.

normative, although the facet structure is used to generate a questionnaire. Subsequent analyses, however, will eventuate in a descriptive result.

The actual mapping sentence has the following form:

The extent to which respondent (x) reports that {People} {Attitude behaviour} {Locus} {Activity} {Context} under {Operating conditions} → {very much . . . not at all}.

where the bracketed words are particular slots for the facets mentioned in Table 5. Based on this mapping sentence some 432 ($4 \times 3 \times 2 \times 2 \times 3 \times 3$) questions can be generated, which can be evaluated by respondents on a seven-point (very much/not) at all response scale. Their study resulted in a 16-scale solution, arrived at through SSA (Guttman, 1968). SSA is not so much aimed at an orthogonal *solution* in a low dimensional Cartesian space as, for instance, is FA or PCA, but more at some *configuration* in a low dimensional space (see Borg, 1981, for examples of these configurations). As already remarked, the scales from this study are therefore not dimensions and if they are, they are oblique, which means that they are correlated. In this way, the Safety Research Unit identifies a few major categories around which safety attitudes are formed.

Table 5
Facets in the Safety Research Unit (1993) study

People	Attitude behaviour	Locus	Activity	Context	Operating conditions
1. self	1. knows about	1. your job in particular	1. passive	1. preparations	1. normal
2. supervisor	2. is satisfied with	2. safety in general	2. active	2. actions	2. maintenance
3. manager	3. carries out			3. checks/ revisions	3. special
4. workmates					

The formulation of the model put forward by Berends (1995b) started with open, unstructured interviews — not unlike free association — with personnel at several companies around the issue of safety. Recurring themes or statements from the interviews were grouped by several independent judges into categories. Their corresponding categories formed the building blocks for the final model. In this model, two broad classes of statements underlie all other categories; norms and beliefs. Norms are subdivided into individual, interactional and organisational norms. These categories are broken down again into several sub-categories. Beliefs on the other hand, are immediately broken down into sub-categories (Fig. 3). The remarks and statements collected in each of the sub-categories are thereupon reworked into questions. In a subsequent survey the model was only partly verified. The FA yielded mostly norm-factors while the beliefs-factors were not confirmed in the study. Factors resulting from this study are shown in Table 4.

A truly normative — or better still — prescriptive model of safety culture is put forward by Geller (1994). Geller distinguishes three “dynamic and interactive factors” (p. 18–19):

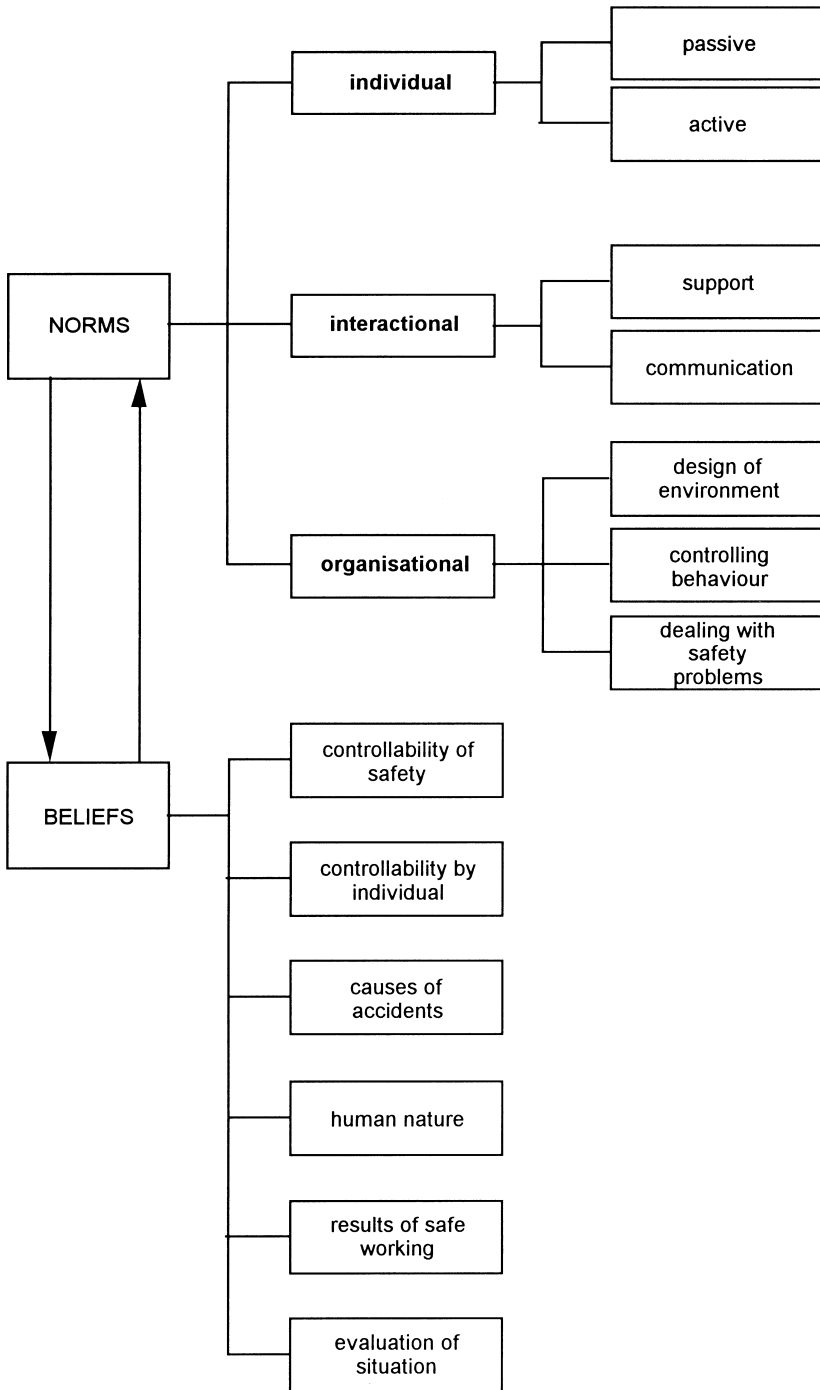


Fig. 3. Berends' (1995b) safety culture model.

1. person, i.e. knowledge, skills, abilities, intelligence, motives, personality;
2. behaviour, i.e. complying, coaching, recognising, communicating, demonstrating active caring; and
3. Environment, i.e. equipment, tools, machines, housekeeping, heat/cold, engineering.

Moreover, he puts forward 10 principles that form the foundation for a total safety culture. Through “five processes or intervention domains” these principles should be implemented. Basically, Geller applies principles of behaviourism and social learning theory to the field of safety. The relationship between all the components of his model is not defined, nor are they prioritised.

Despite the obviously different approaches, several similarities could be pointed out. For instance, especially both the Cox and Cox and the Safety Research Unit studies focus on attitudes, but also the studies by Berends and Geller yield attitude objects.

This is an appropriate place to say something about attitudes and attitude research in general. Attitudes were defined above as “a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor” (Eagly and Chaiken, 1993, p. 1).

In Fig. 4 the processes preceding and the responses resulting from attitudes are depicted (adapted from Eagly and Chaiken, 1993). With regard to attitudes, it is theoretically possible to separate antecedents from consequences, although both may be of the same order. Perceptions and beliefs are only one process or result within this model, namely a cognitive one. Hence, neither perceptions nor beliefs are attitudes.

Attitudes are always directed at an object, i.e. the entity in the definition above. This entity could be virtually anything, as long as it is somehow discriminable, e.g. abstract objects like policies or safety; concrete objects like personal protective equipment or fire extinguishers; behaviours like risk taking or rule violations. Most

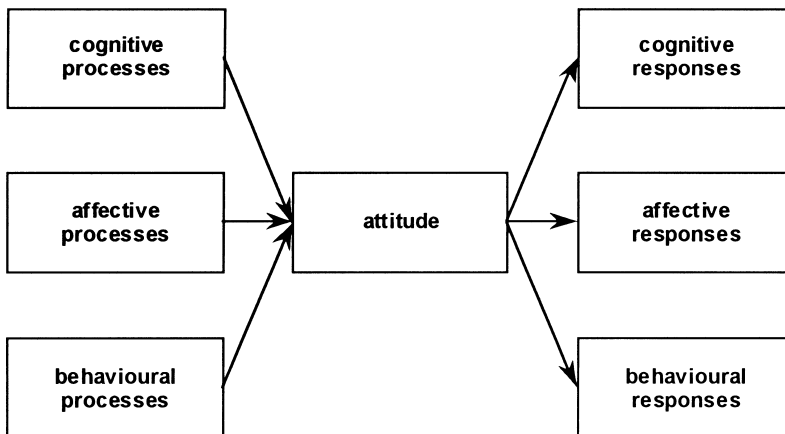


Fig. 4. Simple attitude model (Eagly and Chaiken, 1993).

of the models described above suggest such attitude objects. For instance all models include a people category. Using Cox and Cox's categories of attitude objects, i.e. hardware, software, people and risks it would be possible to link Berends' and Geller's models but not the model put forward by the Safety Research Unit.

Interestingly, the demarcation between norms and beliefs in Berends' model could be traced back to the distinction made earlier between descriptive and affective statements about organisational climate, although in his model this distinction is not worked out this way. Another way of looking at this distinction would be in Schein's terms of levels of culture, where the category defined as norms would pertain to 'espoused values' and the beliefs category then would correspond to his 'basic assumptions'. Measuring norms, i.e. 'espoused values' through a self-administered questionnaire would be feasible according to Schein, but trying to measure beliefs in this way, i.e. 'basic assumptions' would be bound to fail, which is exactly what happened in Berends' study.

All in all, the models on safety culture are unsatisfactory to the extent that they do not embody a causal chain but rather specify some broad categories of interest and tentative relationships between those. In my proposed terminology, at best they are about the *content* of safety climate, i.e. the objects of safety attitudes.

However, this is not to say that the issue is not also addressed elsewhere. For instance, the domino model underlying the International Safety Rating System (version V) positions the measurement of safety attitudes, i.e. safety climate, at the front of safety audits. Within this model, safety attitudes are the primary cause underlying all incidents. From the domain of risk analysis a model has been put forward that represents safety culture, along with other aspects, as an all-pervading influence (Tuli and Apostolakis, 1996). Nevertheless, safety culture itself is still isolated and 'uncaused'. With regard to these last two models it could be said that they are normative models that focus on the *consequences* of safety culture.

Researchers in the field of safety management have also reflected on safety culture. Reason (1997) spends a full chapter on safety culture — its components and engineering — as do Hale and Hovden (1998), who deliberate safety culture in considerable detail. However, a discussion of these views is considered beyond the scope of this paper. Nevertheless, it should be noted that the concept of safety culture has raised the interest of researchers in many related fields. Additional approaches of interest are reviewed in Section 3.5.

In conclusion, at present there is no overall satisfying model of safety climate or safety culture. However, throughout the paper several building blocks for such a model have been indicated. For instance, a distinction was made between culture and climate, which was associated with the layered model by Schein (1992). Climate was equated with espoused values, which were thereupon identified as attitudes. As a result, an organisation's safety climate is made up of its members' safety attitudes. Also, the objects of attitudes were mentioned. Following the current line of reasoning these would make up the content of safety climate, while safety culture could be denoted as their cause. Finally, safety climate's consequences would be the evaluative responses, whether cognitive, affective or behavioural. In Schein's terminology these would be called "artefacts".

3.4. *Level of aggregation*

In the above discussion of organisational culture and climate, it was indicated that the level of aggregation is an important point for reflection. Therefore, it is somewhat surprising that this point has not been given due attention in safety culture and climate research. For instance, when talking about the objects of attitudes one can seriously question whether these objects remain the same at different organisational levels. That is, it is at least doubtful that the attitude objects of individuals are the same as those for groups or organisations. Hence, when aggregating individual data to the level of an organisational group or unit, it is open to question whether the combined data actually correspond to an attitude object existing at that level.

Moreover, as discussed previously, at each particular level of aggregation the issue of communality arises — a certain amount of homogeneity of opinion is needed in order to be able to speak of shared attitudes or assumptions.

This is not to say that it is not possible to compare aggregated data, but by aggregating data one does not necessarily get information about attitude objects pertinent at that level of aggregation. To obtain data valid at a certain level of aggregation, one should ask questions about objects pertinent at that level. In all other cases one still has data about the individual level. To ensure that their respondents consistently give answers about the whole organisation and not about the work-group De Cock et al. (1986, p. 7) included this requirement in the instructions of their questionnaire.

At first sight, these recommendations seem sensible and easy to follow. However, when working with questionnaires, one is confronted with several phenomena like ambiguity, poly-interpretability, the lack of clarity of long sentences, etc., which threaten the validity of the results. Obviously, giving answers to questions not about one's own personal environment but about the whole organisation requires a significant cognitive effort. It is to be expected that respondents will replace such abstract references with their personal substitutions.

As has been said earlier, this issue has not got the attention it warrants. Additional research is needed to shed more light on this issue, the severity of its consequences and possible solutions.

3.5. *Other approaches*

Up to now, the main focus has been on applied research conducted in the tradition of social or organisational psychology.

The Total Safety Culture (TSC) advocated by Geller (1994) is not a diagnostic or evaluative questionnaire-based approach, but is actually aimed at changing the safety culture in a desired, pre-defined direction through mostly behaviour-directed processes. A TSC can be developed when employees understand and accept the 10 principles outlined by Geller. This objective is accomplished by the application of five action plans. Geller does not indicate to what kind of industrial organisations his TSC applies or what kind of preconditions are necessary for successful application. It seems that it is argued that just the rigorous utilisation of the five action plans will result in a TSC.

The report on safety culture by the International Safety Advisory Group (1991) also follows a normative approach. According to them, safety culture consist of two elements, a “necessary framework within an organisation and [...] the attitude of staff at all levels in responding to and benefiting from the framework” (p. 5) and applies to both organisations and individuals within those organisations. Establishing a safety culture means specifying demands at several levels, i.e. requirements at policy level, requirements on managers and responses of individuals. For each of these levels requirements are specified. These pertain, among other things, to knowledge and competence, commitment, motivation, supervision, individual awareness and responsibility. With “framework” the International Safety Advisory Group implies “organizational policy” and “managerial action” (p. 2). Although attitudes are considered “generally intangible” they have manifest outcomes and particular satisfactory indicators are provided by the International Safety Advisory Group.

The safety culture audit method outlined by Ludborz (1995) is to a large extent comparable with the survey approach discussed extensively in this paper, in that it attempts to quantify particular safety culture indicators. However, this is not attained by an extensive survey, but rather through interviews with key individuals and employees and through observations, as is common practice in (safety) management audits. Through the analysis of both “documented and lived structural organisation” and “documented and lived operational organisation”, shortcomings in implementation are assessed. The method defines ten broad areas of analysis, which are investigated by means of checklists with detailed indicators, which have to be scored separately. Safety culture is used here normatively in that it is applied exclusively to organisations with a positive assessment for all 10 areas with above-average frequency. Varying results are considered an indication of the existence of subcultures or counter-cultures. In that case the term “lived safety” is applied.

Ludborz correctly recommends never to lose sight of the “cultural superstructure” where safety culture is only part of a corporate culture, which itself is part of an industrial culture and a national culture. As a matter of fact, it is remarkable how few researchers point out this subdivision. It might be very well assumed that safety cultures not only differ between themselves, but also because of differences between industrial and national cultures. It is therefore striking that these sources of variance did not get any attention in the applied researches reported. For one thing, this is because the organisation is normally the highest level of aggregation in organisational psychological research. For another, including both industrial culture and national culture in one’s investigation would complicate matters beyond what is considered practical research. Therefore, approaches other than those that have been reviewed here are more of a theoretical and reflective nature.

The Safety Culture HAZOP by Kennedy (1997) is a modification of the Hazard and Operability Study (HAZOP), which is one of the established techniques to identify hazards in complex engineering systems. A HAZOP session — and, likewise, a SCHAZOP session — is a group-based methodology. This group consists of a chairman, a secretary and a selection of personnel knowledgeable about the safety management process being studied. Through a process of brainstorming and an ensuing, structured discussion, a safety management process — represented in

diagrammatical form — is examined by means of guidewords (e.g. “missing”, “skipped”, “mistimed”) and property words (e.g. “person”, “action”, “procedure/specification”). The result of such a session is a set of safety management area vulnerabilities. Interestingly, the method proposed by Schein (1992, p. 147 ff.) to get an initial view of a company’s organisational culture is not unlike the SCHAZOP approach discussed here.

In his evaluation of the (sociological) significance of the construct Mijs (1992) views organisational culture as part of a trinity that also encompasses organisational regime and organisational structure. Organisational culture and structure as well as regime are aspect systems that can be distinguished analytically. Quite rightly, Mijs warns that one should guard against reification, in that these systems are considered actual sub-systems that can be isolated and manipulated separately. One should take account of the fact that these systems are embedded into a field of forces consisting of national culture, industrial and occupational cultures and situational factors like technology, type of labour, age of organisation and the like. These influences certainly put a limit on what is feasible in terms of change of, for instance, organisational culture.

When industrial and national cultures are also embraced, we find ourselves in the company of sociologists, political scientists or conceptually oriented psychologists. An example of the latter category is Pidgeon. His scope is apparent from the fact that he considers organisations ultimately as sub-cultures within societies (Pidgeon, 1991). In several publications (Pidgeon, 1991, 1997, 1998) he embeds organisational safety culture in its industrial and political environment, where the occasional “man-made disaster”, e.g. Chernobyl, Challenger, Exxon-Valdez, has a profound impact on both political and societal views on safety. According to Pidgeon (1991), a “good” safety culture can be characterised by three attributes: “*norms and rules* for handling hazards, *attitudes* toward safety, and *reflexivity* on safety practice” (p. 135). Although all three attributes are imbued with political or societal thinking, especially the last is facilitated when it is considered at an industry-wide level, where learning is increased substantially through the collection and dissemination of incident and accident data.

Summarising, the approaches toward safety culture that have been discussed in this section to some extent define two extremes of the continuum describing the interpretation of the concept of safety culture. At one extreme, safety culture is normative, having distinct features (Geller, 1984; International Safety Advisory Group, 1991). When these features have been implemented, a safety culture is established. At the other extreme, safety culture is seen as just a small element in a field of distinct forces, i.e. safety culture is relative (Pidgeon, 1991, 1997, 1998; Mijs, 1992). Clearly, the approach that has been the main focus of this paper falls somewhere in between, with particular researchers inclining towards one or the other extreme.

4. The nature of safety culture

The current literature review of safety culture and safety climate has shown that:

1. the concepts of safety culture and safety climate are still ill-defined and not worked out well;
2. the relationship between safety culture and safety climate is unclear;
3. there is considerable confusion about the cause, the content and the consequence of safety culture and climate, i.e.:
 - the cause of safety culture and climate has not been addressed seriously;
 - there is no consensus on the content of safety culture and climate; and
 - the consequences of safety culture and climate are seldom discussed.
4. there is no satisfying model of safety culture nor safety climate; and
5. the issue of the level of aggregation has not received the attention it warrants.

However, this is not to say that nothing has been accomplished, on the contrary. Nevertheless, it is regrettable that few authors have related their work to research by others or have tried to establish an integrative framework. Such a framework is the subject of the next paragraphs and will, hopefully, be useful in steering future research.

4.1. Safety attitudes

Most researchers of culture — whether national, organisational or safety culture — distinguish several levels at which manifestations of culture can be observed (e.g. Deal and Kennedy, 1982; Hofstede, 1991; Schein, 1992). Examples of such levels have been discussed in Section 2.2 above.

For the present framework the three levels of Schein (1992) are chosen, mainly because of their intuitive appeal and the convenience of just three levels. As a reminder, his three levels are:

- I. Basic assumptions.
- II. Espoused values.
- III. Artefacts.

Also, a very global model of attitudes was discussed in Section 3.3. It stated that attitudes are preceded either by cognitive, affective or behavioural processes and that attitudes yield cognitive, affective as well as behavioural responses. Again, three stages can be discerned. However, this model is still very rough and undistinguished. Eagly and Chaiken (1993, p. 209) propose a composite model of the attitude–behaviour relation, which is more specific. There are two important points to be made about this model (Fig. 5). Firstly, this is still a normative model, although it is based on models that have already been tested. Secondly, the model focuses on behaviour and therefore neglects the other two attitudinal responses, namely affective and cognitive responses.

The advantage of this model is that it specifies — albeit very broadly — the processes that precede attitude formation. Earlier in this paper, attitudes were compared with the second layer in the three-layered culture model. Manifestations of culture at this level were called “espoused values”. It is now suggested to equate attitudes with espoused values. Clearly, the processes that precede attitude formation then should

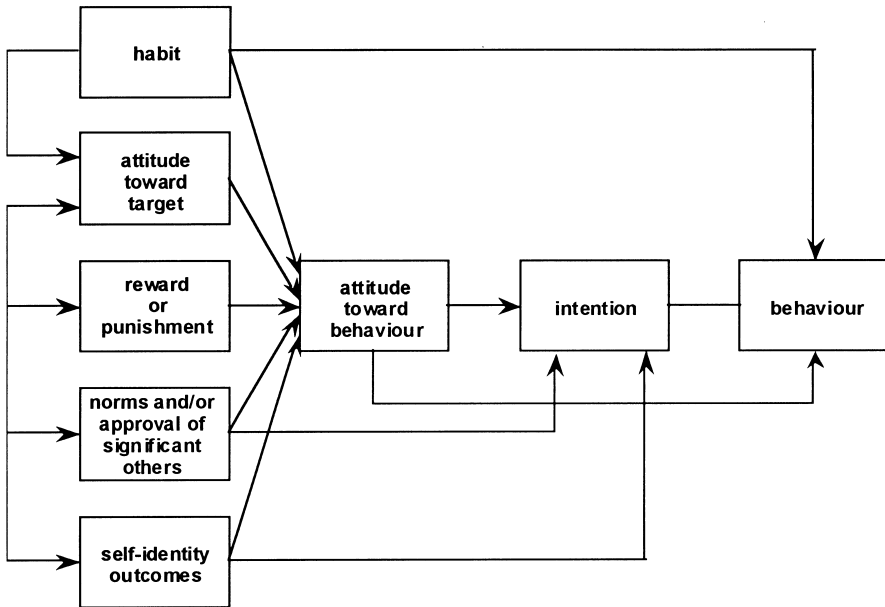


Fig. 5. Processes preceding attitude formation (adapted from Eagly and Chaiken, 1993).

be equated with the core of culture, namely the basic assumptions. I will have more to say about these later.

Up to here, the building of the framework has been neutral with regard to its objective. This framework could be applied to any aspect of organisational culture. However, the present focus is on safety and safety culture.

Attitudes always have objects. Although there are countless objects with regard to safety imaginable, these objects will presumably fall into a few categories. During the discussion of the models that have been devised to account for safety culture and climate phenomena, such categories have already been mentioned. The model by Cox and Cox (1991) for instance, refers to “hardware”, “software”, “people (live-ware)” and “risks”. As a true behaviourist, Geller (1994) suggests “people”, “environment” and “behaviour”, leaving out “software”. Also the accident/incident investigation manual for the US Department of Energy (DOE) mentions “plant-personnel”, “plant-hardware” and “procedural systems” and the interfaces between these three (Johnson, 1985).

It is safe to say then that the following four broad categories of safety attitude objects have some substance:

1. hardware/physical environment;
2. software;
3. people; and
4. behaviour.

Specific examples of hardware attitude objects would be safety measures and arrangements or personal protective equipment. Safety procedures, training and knowledge will come under the heading of attitudes toward software. The category of attitudes toward people will encompass all different kinds of people and groups that can be distinguished within a company, like management, supervisors, colleagues and so on. Finally, attitude toward behaviour will include all acts with regard to safety (or lack of safety) like responsibility, safe working, scepticism and communication about safety.

4.2. *Safety culture: basic assumptions*

Above, something was already said about the core of safety culture, namely the basic assumptions. It would be obvious to assume that these basic assumptions will also be formed around the categories defined for safety attitudes above. However, in the sense that Schein (1992) defines them they do not have to be. He defines basic assumptions as “the implicit assumptions that actually guide behaviour, that tell group members how to perceive, think about, and feel about things”. Such assumptions “have become so taken for granted that one finds little variation within a cultural unit. [...] [M]embers will find behavior based on any other premise inconceivable” (p. 22). Hence, such premises might be specifically about safety but do not necessarily have to be so. For example, if in some organisation written rules or procedures are considered futile, safety rules will be too. Therefore, one might find negative attitudes toward software (rules and procedures) in this organisation. This finding does not mean, however, that the basic assumption is that only safety rules are futile but that rules in general are.⁸

Envisioned this way, basic assumptions can only function as explanatory variables, i.e. they explain the attitude structure found. Moreover, basic assumptions have a more pervasive influence than attitudes, in that basic assumptions transcend particular organisational units like groups or departments or particular types of culture like safety culture.

Now we can also see how these hypothesised basic assumptions link to the pre-attitude components of Fig. 5. These categories are habits, attitudes toward targets, utilitarian outcomes, normative outcomes and self-identity outcomes. It is not hard to consider some of these as basic assumptions. For instance, utilitarian or normative outcomes, which pertain to reward or punishment and the approval of significant others, respectively (Eagly and Chaiken, 1993, p. 209), are usually deep-rooted organisational processes (Schein, 1992). Habits also reflect deep organisational convictions about what works and what does not.

The attitude toward the target might also be a strong, basic assumption. For instance, in a production company a high production is usually considered the greatest good. It should be, otherwise the company will go broke in the short run —

⁸ For instance, because they provide a means for excuses like “I didn’t do it, because the rules didn’t say I should” as the author encountered in one particular company.

the whole organisation is generally leavened with this fact. Therefore, individuals might break certain safety rules because of the greatest good — which is production.

In this representation, an organisation's basic assumptions are completely moulded into the cast of attitudes and their corresponding models. This is just one way of getting a firmer grip on an organisation's basic assumptions. Schein (1992) also mentions particular dimensions, around which shared basic assumptions form (p. 95–96):

1. The nature of reality and truth — these assumptions generally define what is real and what is not, or, more specifically, what is safe and what is not;
2. The nature of time;
3. The nature of space — these dimensions define the importance of time and space within an organisation, how they are used and filled. When related to safety, these dimensions could reveal the assumptions about workplaces, their hazards and their housekeeping and the time spent on safety, preparation of work and work itself;
4. The nature of human nature — this dimension reflects assumptions about people's intrinsic qualities and what can be done about them, e.g. whether some people are accident prone or likely to engage in risky behaviour;
5. The nature of human activity — these assumptions define what is 'work' and the right thing for people to do in relation to their environment; to what extent people should take initiative or await instruction;
6. The nature of human relationships — this dimension is all about how people relate to each other, e.g. competition, individualism, co-operation, authority of individuals, including issues like whether it is acceptable to correct other people's unsafe behaviour.

Clearly, Schein's dimensions are themselves rather abstract concepts, in contrast with more concrete categories of the attitude model. Attitude models like the one above, are usually tested in a laboratory setting. Here, subjects fill out some questionnaires and their responses are subjected to a linear structural relations analysis demanding a numerical input. The questionnaires therefore contain some well-delineated constructs, assumed to be of relevance, that are covered by several questions. On the other hand, Schein's dimensions have more of an anthropological nature seeking understanding rather than reduction. Although both category systems cannot be reduced to one another, it appears that there is still considerable conceptual overlap. For instance, the basic assumptions about human nature will certainly encompass habit formation and beliefs about self-identity. Or, attitudes toward (the approval of) significant others (Fig. 5) most certainly reflect basic assumptions about human relationships.

4.3. Safety culture redefined

Schein (1992) defines organisational culture as:

a pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well

enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems (p. 12).

Schein has included two of the three responses commonly associated with attitudes, i.e. cognitive (“perceive”, “think”) and affective (“feel”) responses. He has deliberately left behaviour out, which he reserves for the outer layers, i.e. espoused values and artefacts. Schein also limits his definition to what he assumes is the core of organisational culture. Actually, in the way Schein conceives and defines (organisational) culture, there is no need for a specific definition for safety culture. The basic assumptions permeate throughout the organisation, including its aspect of safety. In this way, Schein remains faithful to the original conception of organisational culture as an overall, integrative concept. When talking about climate and assuming that climate conforms to the espoused values in Schein’s model which are then operationalised as attitudes, it is necessary to define objects for these attitudes. Obviously, depending on the objects of the attitudes, different climates exist.

As observed above, the different types of culture that are to be found in the literature, have only been defined for analytical or practical reasons and to focus the research. Hence, for the same practical reasons, a definition of safety culture will be given. Safety culture is defined as: those aspects of the organisational culture which will impact on attitudes and behaviour related to increasing or decreasing risk.

In summary, the following framework is proposed (Table 6). Safety culture is conceptualised as having three layers or levels at which it might be studied separately. The core is assumed to consist of basic assumptions, which are unconscious

Table 6
Levels of culture, their visibility and examples thereof

Levels of culture	Visibility	Examples
1. Outer layer — artefacts	Visible, but hard to comprehend in terms of underlying culture	Statements, meetings, inspection reports, dress codes, personal protective equipment, posters, bulletins
2. Middle layer — espoused values/attitudes regarding: -hardware, -software, -people/liveware, -risks	Relatively explicit and conscious	Attitudes, policies, training manuals, procedures, formal statements, bulletins, accident and incident reports, job descriptions, minutes of meetings
3. Core — basic assumptions regarding: -the nature of reality and truth, -the nature of time, -the nature of space, -the nature of human nature, -the nature of human activity, -the nature of human relationships	Mainly implicit: obvious for the members, invisible, pre-conscious	Have to be deduced from artefacts and espoused values as well as through observation

and relatively unspecific and which permeate the whole of the organisation. The next layer consists of espoused values, which are operationalised as attitudes. Attitudes have specific objects and therefore this layer is, necessarily, specific with regard to the object of study. For safety culture four categories of objects are suggested; hardware, software, people and behaviour. Finally, the outermost layer consists of particular manifestations, which are also specific to the object of study. With regard to safety one might think of inspections, posters, wearing (or not) of personal protective equipment, accidents or incidents, near-misses or different types of behaviour.

The appeal of this framework is that it fuses safety climate and safety culture and that it also does justice to the integrative, holistic concept of culture as advocated by, for instance, cultural anthropologists. In addition, another elaboration can be made. As has been claimed above, the basic assumptions do not have to be specifically concerned with safety. Although they do not have to be specifically so, it is quite conceivable that some of the organisation's basic assumptions in fact are, when safety is taken seriously within the organisation and reflected upon by all of its members. This would certainly lead to an anchoring of safety within the basic assumptions. This supposition could be converted into a hypothesis stating that it is a good sign that, among the basic assumptions of an organisation, references to safety are made. Conversely, it is suspect when such references cannot be found. It might very well be that one has to conclude that such an organisation does not yield sufficient evidence for the existence of a safety culture.

5. Discussion

This review of safety climate and safety culture research has been largely from a social psychological point of view and has focused primarily on results from 20 years of research in this field. An integrative framework has been proposed, merging safety climate with safety culture and delivering categories for both safety attitudes and basic assumptions that are open to investigation. However, a question that has not been posed yet pertains to the use and utility of the safety culture and climate construct.

As can be seen in Table 1, all researchers have defined certain goals, often being of both theoretical and practical use. Both Lutness (1987) and Bailey and Petersen (1989) outline particular goals that go beyond the mere determination of safety culture, in that they consider such measurement a performance indicator. For instance, Lutness (1987, p. 20) aims to reveal "a safety program's strengths and weaknesses". Bailey and Petersen (1989, p. 20) want to develop an alternative measure for safety performance while "the effectiveness of safety efforts cannot be measured by traditional (procedural-engineering) criteria". These researchers are referring to safety attitude measurement, i.e. what has been called safety climate in this paper.

Hence, the determination of safety climate has been put forward by some authors as an alternative performance indicator, in addition to the more established ones like safety management audits, accidents and incidents and near-misses (see also Budworth, 1996). This means that there should exist strong relationships between all

these measures. As has been asserted before, such relationships have not been reported often. At present, there are few studies which have tried to establish such correlations, i.e. a relationship between safety performance measures and safety culture or climate assessments (e.g. Cabrera et al., 1997; Erickson, 1997). Hurst et al. (1996) report a relationship between certain audited management areas and attitudinal measures. Also, the modification factors resulting from their audit and a self-reported accident measure are highly correlated in their study. Clearly, these relationships need to be explored in more detail to be able to make substantive statements of the usefulness of a safety culture or climate measure as an alternative performance indicator.

Through their empirical, questionnaire-based study, Simard and Marchand (1996) illustrate convincingly the influence of what they call “micro organisational factors” on safety initiatives. Their results show that, especially, participatory supervision shapes the propensity of workgroups to take such initiatives. Possibly, such a type of leadership is a product of an underlying culture.

Relationships, correlations and, in general, comparisons, bring the issue of quantification up front again. With regard to safety climate this should not cause a major problem, because attitudes are usually surveyed through self-administered questionnaires which generally provide such measures in semi-quantified form. The only point to worry about then is getting enough data to be able to make statistically sound generalisations, hereby keeping a wakeful, methodological eye on the measurement level of the data compared. The assessment of safety culture, however, as conceptualised in this paper as a small set of implicit basic assumptions, does not have a numerical counterpart. Comparisons will have to be made in hypothetical if ... then ... statements, like - *if* such-and-such basic assumptions are uncovered *then* we will also find incidents and accidents with such-and-such causes. Clearly, to be able to make such statements, a fair amount of case studies have to be conducted according to the framework presented in this paper.

However, when a given safety culture or climate has been assessed, the next question will certainly be — so what? Most of the safety climate research reported here would yield some scores on certain dimensions. However, those scores do not speak for themselves, i.e. the meaning of the scores will not be obvious. Moreover, because most researchers work with their own dimensions or scales (Table 4), it is impossible to refer to general norms or benchmarks⁹ Even if it is assumed that scores on certain dimensions are conspicuously low, the question will remain — so what? A subsequent strong (management) focus on the content of those low scored dimensions — communication, for example — would violate the holistic character of culture. Again, one runs into this methodological paradox that the analysis methods impose on the data. Usually, the results of the data analyses are uncorrelated dimensions, but in actuality this is hardly ever the case and is also in contrast with the holistic character that is attributed to culture and climate.

⁹ However, both Lee and the Safety Research Unit have large databases making comparisons and relative statements possible.

The present paper has not promoted this approach, though. The assessment of safety attitudes or safety climate through questionnaires, is only part of the advocated approach. The basic assumptions, which are explanatory to safety attitudes, also have to be assessed for a recommendation or fruitful intervention. Actually, subsequent interventions should only be undertaken with detailed knowledge of a company's particular basic assumptions as explanatory variables par excellence. In that case, there are two alternatives for action. Either, an attempt at changing the basic assumptions is undertaken or an attempt at changing the safety attitudes is undertaken, *given* a particular set of basic assumptions. Clearly, the first effort might turn out to be the most difficult to attain, if it is indeed feasible. The latter one, although the most feasible, might still take a few years. For instance, De Cock et al. (1986) mention 5 years. Obviously, assessing safety climate or safety culture with the object of changing it is both ambitious and time consuming, spanning a period a lot of managers will not even see the end of.

Consequently, the measurement of safety climate could be considered an alternative safety performance indicator, whereas the assessment of safety culture provides more insight into the particular attitudes found, hence — paradoxically — yielding the substrate for both safety improvements and unforeseen major accidents (Pidgeon, 1998). As the present review illustrates, research should not be undertaken to develop 'new' safety climate measurement instruments, but should rather focus on the validity of the construct and whether it indeed yields a robust indication of an organisation's safety performance. In addition, increasing research efforts should be directed at developing means to assess an organisation's basic assumptions, for getting a much deeper understanding of "the way we do things around here".

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