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SAFETY CLIMATE: ITS NATURE AND PREDICTIVE POWER

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The field of organisational climate and of specific aspects such as safety climate, has produced a number of theoretical and empirical scientific contributions, and their applied interest is self-evident. The concept of safety climate, which is the main focus of this paper, emerged in the wake of the seminal work by Zohar (1980). The safety climate construct has been used in the literature on safety at work, as either an antecedent of accident rates or as an aspect to be measured for the correct assessment of company safety, or even as consequence of organisational features and actions such as type of company, size and safety investment. However, theoretical development of the concept has not been paralleled by appropriate empirical assessment, especially in the Spanish context. The aim of this paper is to test empirically the main theoretical properties of safety climate through multilevel statistical models, well-suited to this type of research design. Its specific objectives are: a) to empirically test the safety climate property of shared perception; b) to test the predictive power of safety climate in relation to accident rates; and c) to study the relative importance of the different safety climate dimensions in the context of Spanish industry, while statistically controlling for physical aspects of occupational safety.
***Key words:** safety climate; accident prediction; multilevel models.*

El clima organizacional y los climas específicos de diversos aspectos organizacionales, como el clima de seguridad han suscitado abundante literatura, tanto teórica como empírica, y su utilidad aplicada resulta evidente. El clima de seguridad, el objetivo de este artículo, nace de los trabajos seminales de Zohar (1980) y ha sido empleado en la literatura sobre seguridad laboral, bien como antecedente de la siniestralidad laboral, como aspecto a medir para una correcta evaluación de la seguridad en la empresa, o incluso como consecuente de características y acciones organizacionales tales como tipo de empresa, tamaño, inversiones en seguridad. No obstante, el desarrollo teórico del concepto y la correspondiente evaluación empírica de esas características teóricas no han ido en paralelo, especialmente en nuestro contexto. El objetivo de este trabajo es poner a prueba empíricamente las características teóricas principales del clima de seguridad mediante técnicas estadísticas multinivel, idóneas para este diseño de investigación. En concreto los objetivos son: a) someter a prueba la característica de percepción compartida del clima de seguridad; b) poner a prueba la capacidad del clima como correlato de accidentes, su capacidad predictiva; c) estudiar la importancia relativa de las distintas dimensiones de clima en nuestro contexto industrial, una vez controlados estadísticamente aspectos "físicos" de la seguridad laboral.
***Palabras clave:** clima de seguridad; predicción de accidentes; modelos multinivel.*

The concept of organisational climate was initially developed by Lewin, Lippit and White (1939) to examine the influence of social climates developed experimentally for studying the behaviour of children in groups. Most theoretical and empirical studies of organisational climate, however, were carried out from the 1970s onwards (Van Muijen, 1998). The majority of writers on the subject see climate as the shared perception of the organisational situation (Denison, 1990). There has to be a high degree of consensus before individual perceptions can be called climate, that is to say, perceptions have to be shared. The organizational climate therefore refers to the perceptions shared by members of an organisation about its essential properties –its policies, procedures and practices (Reichers and Schneider, 1990; Reusch, 1990).

Two other important attributes of organisational climate are: a) its *multidimensionality*, referring to the multiple facets about which employees can be questioned; b) its potential predictive power, given that it is a concept which tries to explain the impact of the organisation or the social system of the organisation on the behaviour of its employees, its individual components. In relation to this latter aspect, climate has been associated with various personal dimensions, such as absenteeism, productivity or job satisfaction (Van Muijen, 1989).

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Insofar as these policies, procedures and practices are sufficiently clear and visible, they will permit a consensus among employees and generate a clear and well-defined climate, at least at given moments in time. In order for this organisational or work climate to exist, at least two conditions must therefore occur simultaneously:

1. *Intra-organisational homogeneity,* or consensus among the perceptions of employees in the same company and/or sub-group within the organisation, such as plants, departments or work groups.
2. *Inter-organisational heterogeneity,* or differences between workers in their appraisals of climate if they belong to different companies and/or sub-groups such as plants, departments or work groups.

For a climate to be considered as such, it needs to display two other properties: *strength* and *level*. The two are theoretically and empirically distinguishable, and their effects on other variables, as well as the variables which in turn affect them, may be different.

The strength of the work climate refers to the degree of overlap of workers' perceptions in the same unit (company, department, etc.). A strong climate is therefore one with very similar perceptions among employees, where low levels of variation (e.g., standard deviation) would be expected.

By level of climate we refer to the mean value generated by all the workers of the same organisation (or its sub-groups). Thus a high level of organisational climate obtains if the perceptions of policies, procedures and practices are assessed positively on average. Obviously, it is possible to have a climate which is homogeneously good or bad. Therefore, the two concepts, strength and level, are at least in theory distinguishable.

A further attractive aspect of the climate concept as outlined here is the versatility of its application to different organizational domains, as in innovation climate, service climate or safety climate (Zohar, 1980, 2000). Safety climate, the main focus of this study, refers to the shared perceptions of *safety* policies, procedures and practices. Nevertheless, the appraisal of safety climate can be difficult to carry out given, among other things, the need to establish the differences between an organisation's formal policies and procedures and those which prevail in a reality involving competing goals. From the climate researcher's point of view, the latter policies and procedures are the ones to be studied, since they serve the employee as the yardstick against which to measure probable consequences of his or her safety behaviour. Given that safety factors are inherent to any industrial process, and that they compete with other factors of the process, such as task speed or profitability, it is clear that safety policies and procedures have to be considered as relative priorities. Thus, Zohar (2000) proposes that perceptions of safety climate be assessed in terms of the priority assigned to safety policies, procedures and practices in relation to other aspects of organisational functioning.

It is relevant to assess safety climate because theoretical models and empirical evidence show that it affects safety levels, be it in terms of accident rates, safety and/or health audits, or other aspects. As is expected of any work climate, the system at least in part determines the behaviour of individuals who work in the organisation. Therefore, just one attribute of organisational climate is specified and applied to one particular aspect, that of workplace safety and its consequences.

Zohar (2003) has recently proposed a theoretical model that includes both antecedents and consequences of the safety climate. This model posits three main relationships. Firstly, the safety climate would affect workers' expectations regarding the effects of their safety behaviour (first relationship). In other words, it would mediate what the employee expects to happen as a consequence of given safety behaviour. These expectations would in turn mediate the employee's real safety behaviours (second relationship). Finally, in the third relationship, safety behaviour would have an impact on the company's safety figures –accident rates, safety audits, and so on. The strength of the company's safety climate would mediate these relationships, given the assumption that the greater the strength of the climate, the stronger the climate/behaviour link, since the system would exert more pressure on individual behaviour. The model also includes possible exogenous (external) variables, which would play one of two roles. They would either be antecedents of the climate, creating and modifying it –for example, a new Safety Law may encourage more company investment in training, which would in turn change the climate; or they would be antecedents of the safety levels in themselves, such as the level of risk involved in a specific industrial process. In our case we have incorporated, as relevant variables antecedent to safety levels, measurements of workplace risks and environmental conditions, in line with Zohar's theoretical model (and empirical results, such as Zohar, 2000); these are also compatible with Neal and Griffin's model of safety climate and behaviour (2004), and with verified empirical results which situate workplace risks and environment as antecedents of safety behaviour (and therefore of accidents). A further justification for including measurements of workplace risks and environment in the statistical models is the need to control statistically for them when assessing the impact of climate factors on accidents, since effects can easily be confused.

There are pragmatic reasons for measuring, safety climate if this is a (direct or indirect) antecedent of, say, accidents at work, since as a precursor it could be a suitable proactive prevention measure. Indeed, the usefulness of measuring climate is hindered by the well-known problems of measuring accidents: highly asymmetric distributions, poor record-keeping, relatively infrequent occurrences, and the fact that problems are only indicated once they have happened (Oliver, Cheyne, Tomás and Cox, 2002).

The main goal of this paper is to put some of the most important attributes of safety climate to the test. More specifically, we set three objectives:

a) Firstly, to test whether climate is indeed a shared perception, and therefore whether employees in the same company have at least partly similar attitudes to safety policies, procedures and practices.

b) Secondly, to test whether safety climate as a multi-dimensional construct can be used as an indicator of safety problems. This implies that there has to be a significant link between the different dimensions of climate and some of the safety records of the company. In this article safety climate is considered in relation to accidents at work.

c) Thirdly, to study which climate dimensions are most relevant when predicting accidents in a particular work context, namely that of Valencia province, Spain, which features many SMBs (small and medium-sized businesses), and whether these dimensions of safety climate still have predictive power even when controlling for physical characteristics, such as workplace environment or risk levels.

The measurement of organisational climate, and in particular safety climate, is usually carried out through employee questionnaires (Rousseau, 1988; Zohar, 1980, 2000). The questionnaires contain a variable number of questions and dimensions or facets of the safety climate at a given time, and of interest to the researchers. Here we shall use a five-factor model of safety climate, developed through research in industrial contexts in a variety of European countries, and described in Cheyne, Cox, Oliver and Tomás (1998). These dimensions, all relating to safety, include: goals and standards, management, communication, individual responsibility and personal involvement of employees. These dimensions correspond generically to the most relevant ones identified in recent reviews of the field (Clarke, 2000; Flin, Mearns, O'Connor and Bryden, 2000).

By studying the structure of, and the relationships within, safety climate in a Spanish sample, we attempt to understand and reduce the problem of occupational accidents, of which Spain has one of the highest incidence rates in Europe (Dupré, 2001). Some of the reviews of Spain's safety statistics suggest that accident prevention is still focused on risk assessment and technical factors (Sesé, Palmer, Cajal, Montaño, Jiménez & Llorens, 2002), rather than on the psychosocial factors considered in a safety climate analysis.

METHODOLOGY

Research design and procedure

The design of the study is quasi-experimental, using a cross-sectional survey of a population of workers in the Valencia province of Spain. Workers were interviewed when they came for preventive health checks at a Workplace Health and Safety Centre which in the Valencia province attends largely to people working in SMBs. The sampling period covered the end of 2000 and the beginning of 2001. Surveys were carried out during the normal opening hours of the centre, with confidentiality guaranteed at all times. The specific procedure consisted in asking respondents, before the health check, to complete a self-report questionnaire with all the measures used in the work, as well as others. The procedure was supervised by Health Centre staff trained for the purpose, who provided help when needed.

Sample

A two-stage random sampling design was employed, involving companies and workers. First, a number of companies were randomly selected from those planning to send their workers to the Centre. In the second stage, a number of workers from these companies who attended the Centre were chosen at random. The final total sample consisted of 510, selected from 937 possible workers, from 90 different companies. The reason for the reduction from 937 to 510 was that in order to ensure sufficient homogeneity it was decided to reject companies where less than three workers answered the questionnaire. Participant ages ranged from 16 to 64 years, with a mean of approximately 34 years and a standard deviation of 9 and a half years. Most respondents (83%)

were general employees; 10% were supervisors or middle managers, while executives and directors made up 7% of the sample. Respondents represent a wide variety of sectors: chemical (6.1%) and metal (49%) industries, commerce and tourism (3.5%), educational and health services (5.3%), administration and banking (7.6%), construction (6.5%) and other manufacturing industries (2.4%), and finally other services (19.6%).

Measurement instruments

The measurement instruments included in the questionnaire are based on those developed in joint research between the universities at Loughborough (UK) and Valencia (Spain), the psychometric properties of which are detailed in Cheyne et al. (1998). All the questionnaire measures were generated simultaneously in English and Spanish, and validated in both languages. For the most recent validation references of the Spanish version, consult Díaz (2005) and Cheyne, Oliver and Tomás (2005).

The questionnaire comprises five sections which gather information about the following dimensions:

1. Socio-demographic Worker's personal data, such as age, sex, level of education; job data such as type of job and contract; company data, such as sector or size.
2. Accident rate For each worker four different indicators of occupational accidents are included, covering the two years prior to the survey: a) number of near misses in which there could have been an accident but nobody was hurt; b) minor accidents after which nobody had to be off work; c) accidents resulting in up to three days off work; and d) severe accidents resulting in more than three days off work. *In itinere* accidents during travel to and from work are excluded. The accident rate dimension is based on individual questionnaire responses because the organisation that allowed us to carry out the survey and use the health centre would not authorise us to gather objective data on occupational accidents and other dimensions on the grounds of data privacy protection. Nevertheless, some of the measures are objective (such as the accidents with days off work), and in prior studies by the same authors with identical accident measures (for example, Oliver et al. 2002, or Cheyne, Oliver and Tomas, 2005), as in this paper, it was analyzed whether the accident indicators correlated strongly with near misses (more subjective and possibly biased), and whether they constituted single factor, which would allow us to be surer about the data obtained here. This was found to be the case on both occasions, and furthermore, given the difficulties in predicting accidents due to the low levels of variability and asymmetry, it did not seem sensible to reject the measure with highest variability, lowest asymmetry and high theoretical relevance. The response scale is ratio-based: respondents enter the number of near misses/accidents.
3. Quality of basic working conditions, including humidity, ventilation, temperature, workspace. A five-point Likert scale is used.
4. Risks checklist, including 32 common chemical, electrical and mechanical hazards. The frequency of these is rated (from 0 to 3), as is the severity of their consequences (from 1 to 3). On the basis of these, an overall risk rating is calculated, in which the risks with more severe consequences receive a higher weighting. The hazards are taken from the general checklist used by the WHO in its reports.
5. Finally, the organisational climate is measured using a scale with 5 dimensions and 30 indicators. All questions are scored on a 5-point Likert scale. The climate dimensions are indicators of the safety goals and standards of the company, safety management, communication on safety issues, personal involvement of the employees in safety issues, and individual responsibility for accidents as *perceived* by the employees.

Analysis

In two-stage sampling designs such as the one used here there are two levels of random sampling, firstly companies and secondly, workers belonging to the selected companies. This procedure, which can be complicated by adding intermediate levels such as departments or work groups, produces dependence in the observations. The second-level observations are not independent of each other, given that the choice of the higher-level unit increases the selection probabilities of lower-level units. The degree of dependence found among the lower-level units, in this case workers, can be estimated using the intraclass correlation coefficient (ICC). A statistically significant ICC would indicate that the workers of each company do indeed share a similar vision of the variables, for example the climate dimensions, allowing to test for a definition of climate as a set of shared perceptions to the empirical test. The ICCs have been estimated through the application of multilevel variance components models for each of the climate factors, for the measurement of risk and that of environmental conditions.

If dependence is indeed found in the data, it will be indicative of the shared nature of climate and would mean that one of the underlying assumptions of the general linear model is not fulfilled. Therefore, statistically significant ICCs indicate the need to evaluate multilevel models. In fact, the general linear model assumes independence of the observations, and non-fulfilment of this assumption implies significant biases in the estimations, such as negatively biased standard errors, in such a way that the significant results are higher than the nominal alpha used. The "classic" solutions to the problem are the aggregation of sub-unit data, or the disaggregation of data for higher level units, in order to apply the general linear model. These solutions throw up important substantive and statistical problems, such as the ecological fallacy, Simpson's paradox, or loss of statistical power (see, for example, Hüttner & van den Eeden, 1995; Lindley & Novick, 1981; Robinson, 1950). To resolve these problems and put the relationships of climate dimensions to the empirical test, hierarchical linear regression models, which are multilevel models, were applied. These models resolve the problems of dependence and it becomes possible to study simultaneously variables of the two levels of analysis, company and individual. Even if the interest of the study lies in predicting variables at the lower level through other variables also measured at the level of the individual, this type of model is suitable for correcting the effects of dependence between subjects, if it exists, thereby obtaining reliable results (Hox, 1995; Snijders & Bosker, 1999).

The multilevel models used in this study are random-constant, both simple and multiple, developed using the Mlwin software (Rasbash, Steele & Browne, 2003). Prior to the estimation of these multilevel models, a detailed study was carried out of the conditions of use for the regression. More specifically, graphs of residuals were created and atypical values were studied in Y (outliers) and X (leverages), as well as values of influence. Finally, collinearity among predictors was assessed for the multiple regression.

RESULTS

Initial analyses try to test the hypothesis that safety climate is a shared perception. For this purpose ICCs were calculated for each of the five dimensions of safety climate, and additionally for the risk level and environmental conditions assessed. There are different definitions of this coefficient, depending on the sampling model employed. In the case of the two-stage stratified sample, with two levels of randomisation, it may be assumed that some variation among the scores analysed depends on the employee's personal and job characteristics, but a further part of the variation in the scores can be put down to working in a particular company with particular conditions.

If the workers in a particular company do not share the same vision of safety policies, procedures and practices, their scores on the variables are independent of each other and, as a consequence, the ICC should be zero or statistically non-significant. If, on the other hand, workers share their vision to a certain extent, the ICC correlation should be other than zero, i.e. statistically significant, increasing as the level of agreement in the scores of workers of a given company rises, in contrast to those from other companies.

To estimate these ICCs it is necessary to assume that there is an infinite (or sufficiently large) number of companies and workers from which the random sample has been drawn. If these assumptions hold, a relevant statistical model to estimate the amount of ICC is the random effects ANOVA model. The structural model states that a score of worker *i* from company *j* (Y_{ij}) depends on,

$$Y_{ij} = \mu + U_j + R_{ij} ,$$

Where μ is the mean in the general population, U_j is the specific effect of company *j*, and R_{ij} is the residual effect (error) for worker *i* within company *j*. The variability of the different companies, that is, the variability of U_j, is the *between-group populational variance* (τ^2), and measures how companies differ in the dependent variable Y, while the variability of different workers within the same company, that is, the variability of R_{ij}, is the *within-group populational variance* (σ^2), and measures the variability of workers' scores in relation to their company's mean. The total variance of Y_{ij} is the sum of these two variances,

$$\mathrm{Var}(Y_{ij}) = \tau^2 + \sigma^2$$

If scores depend heavily on which company the worker belongs to, the between-group variance (τ^2) will be larger than the within-company variance (σ^2). However, the opposite will be the case if employees' scores do not depend on the company they work for. The ICC can thus be defined as

$$ICC = \tau^2 / Var(Y_{ij}) = \tau^2 / (\tau^2 + \sigma^2)$$

This correlation coefficient measures the proportion of variance that is accounted for by the company level of analysis, the proportion of individual variance depending on the worker's company. It ranges from 0 to 1, with 0 indicating that all the variance in the scores is accounted for by the worker's job and personal characteristics, and 1 indicating that all the variance in the scores is accounted for by the company each worker belongs to. Searle, Casella and McCullogh (1992) offer more information on calculating the ICC and testing its significance with this and other types of sampling strategy.

Thus, the ICCs were calculated for the five dimensions of safety climate, work environment conditions, risks and total number of accidents. These are all shown in Table 1, and as it can be seen, they have turned out statistically significant ($p < 0.05$), but with different amounts. These correlations within each company, on being significant, indicate, on the one hand, that perceptions of safety conditions are partially shared; on the other hand, they suggest the need to employ hierarchical models in the prediction of accidents with survey designs of this type, as outlined below.

First of all, seven hierarchical regression models with random constant were estimated. These regressions correct the effects of the errors brought about by lack of independence, since they permit the variability derived from belonging to a particular group to be accommodated in the equation. Structurally, the simple hierarchical regression with random constant can be expressed for individual *i* of company *j* (Snijders and Bosker, 1999),

$$Y_{ij} = \gamma_{00} + \beta_{10} x_{ij} + U_{0j} + R_{ij} \; ,$$

and where γ_{00} is the mean constant for all companies in the study, β_{10} is the gradient that relates X with Y values, U_{0j} is the main effect of company *j* (and which the ICCs tell us is different from zero in all cases), and R_{ij} is the residual variability of subject *i* in company *j*.

The results of these hierarchical regression models allow us to answer the question of whether it is possible to use safety climate factors as indicators of safety threats. For this to be the case, it is necessary to show that there is a statistically significant link (and in the appropriate direction) between these and accident rates. In the first column of results in Table 2 we can see the estimations of the effects of predictors on accidents, the estimations of the gradients for each predictor. The next column shows their standard errors, and finally the standardized gradient, showing the level of statistical significance. All the predictors turn out to be significant indicators of accident rates. Finally, Table 2 (columns 4 to 6) also shows the results of the *multilevel multiple regression with random constant*. This multilevel multiple regression takes as predictors the five climate factors, workplace conditions and risks simultaneously, allowing us to see which are more relevant in predicting accidents and at the same time whether the safety climate dimensions still have an effect on accidents when risks and workplace environment are controlled statistically. In terms of global fit, the introduction of predictors means a statistically significant reduction in the chi-square statistic with respect to the null model ($\Delta x^2 = 93.926$, $\Delta x^2 = 7$,

Table 1
Intraclass Correlation Coefficients

Variable	ICC
Work environment	0.17
Workplace risks	0.18
Safety goals and standards	0.22
Safety management	0.25
Communication	0.19
Staff participation	0.07
Individual responsibility	0.09
Accident rate	0.07
All statistically significant coefficients	p<0.05

Table 2
Hierarchical regression models with random constants

	Simple hierarchical regression			*Multiple hierarchical regression*		
Predictor	**B**	**SE**	**β**	**B**	**SE**	**β**
Environment	–0.894	0.193	–0.203***	–0.497	0.214	–0.113*
Risks	0.037	0.005	0.302***	0.024	0.006	0.196**
Goals & Standards	–1.418	0.180	–0.324***	–1.079	0.185	–0.246***
Management	–0.945	0.223	–0.192**	0.259	0.432	0.053
Communication	–0.859	0.195	–0.201**	–0.329	0.337	–0.077
Participation	–0.997	0.213	–0.202**	–0.144	0.304	–0.029
Responsibility	–0.503	0.242	–0.092*	–0.157	0.284	–0.028

Notes: B= non-standardised coefficients; SE= standard errors; β= standardised coefficients.
*p<0.05, **p<0.01, ***p<0.001.

$p < 0.05$), and in percentage terms the error variability of the model without predictors (beyond the company itself) falls by 17.57%. Consequently, it can be concluded that, on a general level, the predictors do contribute to an explanation of accident rates. In this table we can see that only three predictors remain significant: workplace conditions, risks, and safety goals and standards.

CONCLUSIONS AND DISCUSSION

Our conclusions must revolve around the main goal of the study, that is to say empirically testing one of the core assumptions of the organisational climate concept, namely its shared or social nature. Climate has to be at least partly socially created and shared, and this should be reflected in the assessments of the people who work in the same organisational context. Despite being common, this theoretical assertion has not been rigorously tested in the Spanish context. Our intraclass correlation results show that in all the dimensions of climate there are statistically relevant degrees of overlap among the perceptions of workers' from the same company. They also show that there is a greater percentage of variance by company in some of the factors, essentially those relating to external features, such as physical environment or work organisation, compared to lower variance across more personal conditions, such as personal responsibility. We should like to emphasise that the coefficients found are statistically relevant, not negligible in any case, and that they must be taken into account statistically as indicators of a lack of independence, implying non-fulfilment of an assumption of considerable relevance for estimates; indeed, values close to 0.10 can be seen as highly problematic (e.g., Bryk and Raudenbush, 1992; Rasbash et al., 2003). Nevertheless, it is clearly a different question whether these statistically significant coefficients are large enough to show that climate is indeed shared. Here the evidence is partial, and the values obtained for the coefficients need to be compared across the field. In similar organisational studies, values have been found ranging from 0.15 (e.g., van Yperen, van den Berg, and Willering, 1999) to 0.25 (e.g., Griffin, Mathieu and Jacobs, 2001). Therefore, we can say that, despite the lack of further specific studies on safety climate, the ICCs for work environment and risks, safety goals and standards, safety management and communication can be considered as indicative of shared perception. Nevertheless, the ICCs for staff participation and individual responsibility are low. What the two groups of variables do have in common, however, is that while the first group measures factors external to the individual and has high ICCs, the second group is logically more likely to present lower levels of shared perception because it is measuring workers' more personal responses, about colleagues or themselves. This conclusion, then, calls into question whether these variables should actually form part of the climate construct (Neal and Griffin, 2003), and strengthens the case for further research in our field. Although the results are relevant, research in the direction undertaken here should go further, with designs involving participants who not only belong to the same company, but also work in the same departments and/or workgroups, in order to discover whether the shared nature of climate increases with greater daily contact among workers.

The second objective consisted in proving that climate is significantly linked to objective safety results, such as accident rates. If this holds true, measuring climate would be a proactive tool for measuring safety at work and its changes, and comparing it to that of other companies (Coyle et al., 1995). This would make it possible to add climate and culture measures to traditional risk analysis, which would help to determine whether changes are necessary, to plan interventions and to assess those interventions over time. Indeed, the results show that climate can be considered as an effective indicator of the "safety health" of the company. If we wait for safety incidents to happen in a company in order to implement vigorous safety measures, these will be palliative, not preventive. Preventive action could be taken, on the other hand, if we could show that at an early stage simple tools (such as questionnaires or surveys) can be used to check whether climate levels are high, and that this could be linked to lower occupational accident rates. Nevertheless, it is clear that not all the climate variables display the same relation to accident rates, which leads us directly to the results related to our third objective.

Finally, the third objective provides results regarding the importance workers give to the different factors measured in the prediction of accidents. It shows us what they think is most clearly linked to accidents. Sesé et al. (2002) claim that safety management in the companies studied is largely based on risk analysis of a technical nature, more akin to engineering exercise. They also consider that there is a prevailing fatalistic perspective prevails among employees (accidents are caused by external factors, there's nothing you can do to prevent them, etc.), who perceive low involvement of the individual. Our own findings corroborate these arguments, in the sense that the strongest relationships with accidents (apart from the strongest of all, which is safety goals and standards) correspond to workplace conditions and risk levels; this can be attributed to a reactive perspective on occupational safety, not only at the management level, but widespread among workers, too. In a similar vein, of the climate factors, only safety goals and standards, a high-level factor in terms of general company policy, was linked to accidents. Not so the more personal factors, such as communication, individual responsibility and personal involvement, which only displayed more tenuous links, which in fact disappeared after controlling for the above-mentioned variables. Having said this, however, it is clear that safety goals and standards is the main predictor of accidents, which means that the usefulness of climate measurement as a proactive indicator of potential problems, and therefore as a tool for the prevention of accidents at work, can be upheld. In previous studies by the same authors, with samples from European countries, it has been management, communication and participation factors that have played a central role in the prediction of safety levels in companies (see Cheyne et al., 1998). Nevertheless, the fact of goals and standards being relevant is in part consistent with the literature (Clarke, 2000, Flin et al., 2000), which indicates that high-level organisational safety plans are a fundamental and salient component of any occupational safety initiative.

Proposed lines of future research often –and this case is no exception– emerge out of the need to overcome the limitations of the work done so far. Longitudinal studies, despite their own shortcomings, would better allow us to assess what appear to be causal effects, such as that of climate on accidents. A further limitation of the present study, as of many other safety climate studies, is the difficulty of using objective measures of some of the concepts considered in the model. Future studies should focus their efforts on obtaining more workers per company, in order to obtain higher resolution in our picture of the shared nature of safety climate and the consideration of other multilevel models.

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