



# Safety culture, safety performance and financial performance. A longitudinal study

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## ABSTRACT

Safety Culture and managing employee relationships in a safe and socially responsible climate might help avoid risks at the workplace and reputational damage for companies. Drawing on the social approach and Occupational Health and Safety Management, this paper aims to gain further knowledge regarding the impact of safety culture through safety performance on financial performance in organisations. We test a set of hypotheses in a panel data of European companies from different activity sectors from 2005 to 2019. Our findings provide strong support for the premise that companies with policies aimed at improving employee health and safety, employee training, or having safety management systems positively influence safety performance, which in turn has a positive impact on financial performance. The development of safety culture in the company is necessary to meet the needs of employees, and thus improve safety performance. This study has implications for both theory and practice and offers some relevant implications for regulators and policy makers.

## 1. Introduction

Occupational Health and Safety (OHS) represents a relevant dimension of the social pillar of Corporate Social Responsibility (CSR). Particularly, safety culture is considered as a part of the organisational culture of a company where beliefs and values refer to safety and health issues (Clarke, 1999). It has been defined as a sub-aspect of organisational culture, which would affect the attitudes of members in relation to the safety and health development in the organisation (Cooper, 2000).

Safety culture must be developed not only at the individual (worker) level but also at the organisational level. For safety culture to evolve in an organisation, several actors must be involved, from management to employee representatives and even external companies. When addressing safety culture, a comprehensive approach should be followed, where technological, organisational, human and external aspects are taken into account as interrelated elements (van Nunen et al., 2016). In this new management style, organisational safety is perceived as a competitive advantage for companies that are starting to change their management style to develop new business models which make them more competitive in the market.

Safety culture has become the focus of much attention in all types of industries in recent years (Fleming et al., 2018). However, the influence

of “safety culture” on “safety performance” and the relationship between safety performance and financial results from an integral approach is underexplored. Few studies address the importance of the relationship between safety performance and financial performance regarding some isolated aspects (Martín-Román and Moral, 2017; Tengilimoglu et al., 2016). Recent research highlights the need for more in-depth research examining, for instance, the evolution of the lost time injury indicator and using more comprehensive databases to carry out a longitudinal study involving a larger number of organisations (Dura et al., 2018). Additionally, the usefulness of employing quantitative methodologies to analyse the relationship between job safety and financial performance has been suggested (de Sousa et al., 2021).

Over the years, the relationship among safety culture, safety climate and safety performance has been the object of some research (see, for instance, (Clarke, 2006; Erickson, 1997; Fernández Muñiz et al., 2009; Kalteh et al., 2019)). In previous literature, a tendency to confuse the concept of safety culture with that of safety climate has been identified (Fruhen et al., 2013). Safety climate refers to a situational element at a given time, whereas the construct of safety culture presents a multidimensional nature and is a concept in continuous interaction. In addition to organisational safety, safety culture is also analysed in other contexts such as health care, associated with patient safety (Arias Botero and

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Gómez Arias, 2017; Weaver et al., 2013), transport (rail traffic, road traffic) (Clarke, 1999; Yung Hsiang, 2011), the aviation industry (Patankar and Sabin, 2010; Wiegmann et al., 2009), the food industry, education, and household accidents (van Nunen et al., 2018). Due to this multidimensional character, there is no consensus about the concept and its measurement (Sook Shuen and Wahab, 2014; Wiegmann et al., 2009).

As safety culture influences the behaviour of employees, it is related to safety performance. In this regard, in recent years, safety culture in organisations is focusing more on the human dimension rather than on technical aspects (van Nunen et al., 2018), although the latter should not be downplayed (Reiman and Rollenhagen, 2014; van Nunen et al., 2016).

Our study aims to delve into the influence of safety culture on safety performance, and the consequences of this on a firm's financial performance. This research question is relevant in all economic sectors. For example, construction, metallurgical or manufacturing sectors usually present higher accident rates than other sectors. In turn, health or service sectors are more prone to suffer occupational diseases or exposure to psychosocial or chemical risks (Bautista-Bernal et al., 2021), which can also lead to occupational accidents.

We make several contributions to the extant literature. Firstly, we expand on the previous contributions by examining, from a holistic point of view, the impact of safety culture on safety performance and how it affects financial performance. This responds to the need for more in-depth research linking the concept of safety culture to the economic and financial performance of companies to foster the commitment of managers and incentivise the effectiveness of sustainable strategies (Dura et al., 2018). Secondly, this research is international and multi-sectorial since it is based on a large panel data of European companies from all sectors. This allows us to avoid the selection bias that previous work might include by focusing on a single sector of activity (Dura et al., 2018; Fruhen et al., 2013). Thirdly, we contribute to the literature by presenting quantitative research findings. Fourthly, this is a longitudinal study, undertaken over a period of 14 years, which is particularly useful to explore how causal relationships vary over time. Finally, our research differs from others in that it incorporates an indicator of the level of implementation of CSR, to examine if CSR represents a framework that supports the policies regarding OHS.

This paper is structured as follows. It begins by describing the theoretical framework and hypotheses. Subsequently, measurements, empirical analysis and results are presented. Finally, the discussion and conclusion sections with practical implications, limitations and directions for future research are exposed.

## 2. Theory and hypotheses

### 2.1. Safety culture: concept, measuring and models

There has been a growing interest in the area of safety culture research (van Nunen et al., 2018). However, due to its complex nature, there is no consensus on its definition (Guldenmund, 2000), causes, consequences, or indicators (Reiman and Rollenhagen, 2014). In the research field of safety culture, two different aspects can be distinguished: organisational safety culture, with a more theoretical approach, and safety culture oriented to health care and patients that presents a more practical-oriented emphasis (van Nunen et al., 2018).

Many authors consider the terms safety culture and safety climate interchangeable (Fruhen et al., 2013; Sook Shuen and Wahab, 2014). As with the concept of safety culture, there is also no unanimity on the definition of safety climate since Zohar first used it and defined its dimensions (Zohar, 1980). Safety Culture goes beyond individual attitudes and beliefs, encompassing aspects such as preventive thinking, collective responsibility, effective communication, continuous training, proactive risk management and the adoption of safe practices at all levels of the organisation. In fact, in most cases, both concepts are identical in

spite of the fact that they differ in some important aspects. Safety climate is the perception of the state of safety at a given time and is related to situational and environmental factors being a temporary phenomenon characterised by instability and subject to change (Wiegmann et al., 2009). Whereas, safety culture is part of the overall culture of the organisation, and therefore affects the attitudes and beliefs of all members regarding safety and health (Cooper, 2000). Therefore, safety climate can be seen as the surface attributes of safety culture (Flin et al., 2000). It could be considered as the most accessible and quantifiable indicator for assessing safety culture (Sexton et al., 2006) and it has a more passive connotation since it can be influenced by the external environment (Clarke, 2006).

Safety culture is a relatively stable social construct. It is developed gradually over time in an organisation and is influenced by seven enabling factors that contribute to creating the conditions necessary for employees to adopt safety culture values, assumptions and norms. These factors do not define safety culture, but create the conditions that enable its development and could be classified as: (1) organisational level factors: those factors that enable employees to adopt safety culture values, norms and assumptions such as leader commitment to safety prioritisation and safety policies and resources, (2) group level factors: those that enable the development of a safety culture such as cohesion and psychological safety and (3) individual level factors that enable the development of a safety culture over time such as safety-related knowledge, sense of control and individual commitment to safety (Bisbey et al., 2021).

The literature offers numerous indicators to measure the construct of safety culture in an organisation. Some studies focus on analysing the factors and structures that shape this culture, identifying those that have significant value. For example, a recent study focuses on safety culture in the manufacturing industry, examining its different dimensions in engineered products (Suhanyiova et al., 2021). Based on a novel perspective on the social construction of safety culture development, Bisbey et al., (2021), propose that factors often considered as dimensions of safety culture can contribute to its development over time. Additionally, the organisational and social psychology theory is employed to explain how employees can drive the development of safety culture through social identification and learning.

Related to the attributes of safety culture, several key elements have been identified. These include: safety as a recognised and integrated value in all organisational activities, safety leadership and the promotion of safety through learning (García-Herrero et al., 2013). In this sense, to measure safety culture, some studies point to a larger number of dimensions and indicators, such as high-level commitment to safety, organisational learning, fair culture, awareness, organisational flexibility and emergency preparedness (Dos Santos Grecco et al., 2014; Morrow et al., 2014).

Regarding the state-of-the-art of safety, the interaction of organisational culture or organisational climate with safety outcomes have been addressed, as well as the relationship of safety climate with employee attitudes and perceptions of safety (Prinsloo and Hofmeyr, 2022; Zhu et al., 2016; Elmoujaddidi and Bachir, 2020; Xia et al., 2020). Despite the diverse perspectives, there is no universally accepted definition that brings together the details discussed in the literature on safety culture. However, all of them make special mention of values, beliefs, norms, attitudes, roles, practices, perceptions, assumptions, competencies, behavioural patterns, characteristics, priorities and organisational features along with employees, groups, systems, managers, organisations and customers (Bisbey et al., 2021).

Numerous studies highlight the importance of assessing the safety culture in organisations, considering technical aspects, management, awareness and individual and collective responsibility. During the period 1986–2000, several models have influenced safety culture theory, research and practice and they have been used by researchers, regulators and industries. Each model provides a framework for understanding and addressing safety culture in organisations (Cooper,

2018).

The five independent subcultures model of Reason (1998) is based on incident analysis and considers that preventive culture is not a unitary construct but is composed of interacting elements. The author emphasises the existence of an informed culture, supported by an effective information culture and highlights the importance of a flexible culture and a learning culture to promote safety.

Guldenmund (2000) bases his interpretive model on the three-layered framework of organisational culture of Schein (1992), considering preventive culture as a pattern of basic assumptions, beliefs, espoused values and visible artefacts. It recognizes the existence of subcultures within the organisation and proposes the need for meaningful dialogue between all parties in order to minimise negative discrepancies.

Cooper (2000) proposes a reciprocal safety model rooted in a functional approach focusing on psychological, conductual and situational aspects. He uses the social learning theory that considers preventive culture as a subculture of the organisation, and stresses the importance of the interaction between people, jobs and the organisation to promote a prevailing safety culture.

Later on, Parker et al. (2006) conducted a study to analyse safety culture, and offered a model of levels of advancement in safety culture from a pathological dimension to a generative stage where safety and production are fully integrated. Subsequently, Hudson (2007) proposed a three stage model to evaluate safety culture, focusing the first stage on technical and technological aspects, the second stage on management improvements and a third stage on cultural and human awareness.

Organisational safety culture is built and reinforced through individual employees. Safety-related knowledge plays a key role in safety culture by highlighting the relevance of awareness, skills competence, training and education of employees to understand safety procedures, competence and compliance with regulations (Bisbey et al., 2021).

In our study, we adopt a comprehensive approach of safety culture that reflects a technological and management stage, based on co-responsibility, and with a proactive and generative nature.

## 2.2. Safety culture, safety performance, and firm performance: Hypotheses

According to ISO 26000 (ISO, 2010), the prevention of occupational risks, the protection of workers' health, the adaptation of work to the person and working conditions are some of the fundamental aspects to be highlighted and that every organisation should follow.

Workers represent the most important resource of an organisation. Developing initiatives and measures to protect their health and safety should be considered as one of the priorities (Fernández Muñoz et al., 2009). Some researchers conclude that the measurement of safety culture is categorised under the proactive approach of safety performance and they suggest more research is necessary for the benefit of all industries and their employees (Choudhry et al., 2007).

Safety culture may allow the organisation to improve its competitive position. It can include policies oriented to adequate and up-to-date job training, informing workers about the risks in their jobs, and suitable working conditions to perform the job with dignity and safety (Górny, 2014).

The attitude of managers plays a key role in reducing the number of accidents (Hambrick, 2007). Based on accident and literature reviews as well as expert opinions, Markowski et al. (2021), identified the fundamental management and organisational factors that may contribute to an effective process of safety management. Focusing on industrial process installations using hazardous chemical substances, its results confirmed the crucial role of management involvement. Findings identified a strong and engaged leadership as the first and first-ranking component of effective management.

Moreover, there is a need to promote and integrate safety culture at all hierarchical levels of the organisation. Companies with a positive

safety culture are characterised by a collective attitude based on collective commitment, risk awareness, collective learning and trust in prevention. These organisations are distinguished by communication based on mutual trust, a shared perception of the importance of safety and confidence in the effectiveness of preventive measures (Gadd and Collins, 2002). Employee participation, feedback and active listening are key factors in creating a good safety culture. It has been found that the level of safety performance of employees who have received safety training is higher than that of employees who have not received such training (Tengilimoglu et al., 2016).

Bisbey et al. (2021) argue that enabling factors set the conditions for individual employees to adopt assumptions, values and norms consistent with safety culture. Through these elements, safety culture gradually becomes integrated as workers collectively internalise consistent assumptions, values and norms. These beliefs are reflected in employee behaviours, thereby influencing safety performance. Some studies support the positive influence of safety culture on safety performance (Sugiono et al., 2020), demonstrating an effective reduction of accidents and improvement in safety performance indicators (Kalteh et al., 2019). Tengilimoglu et al. (2016) propose a model that demonstrates the positive influence of safety culture on safety performance through the mediation of worker satisfaction and determine that workplace accidents are due to poor working conditions or unsafe practices. Recent research affirms that it is a key question to know to what extent a good safety culture would correspond to a higher level of safety and a decrease in accidents (Aven and Ylönen, 2021).

Based on a sociotechnical and macroergonomic approach, the study by Kalteh et al. (2022) investigates the direct effects of safety culture on safety performance. This approach provides an understanding of how social and technical aspects interact to influence safety in a work environment. In the context of the railway sector in Taiwan, a study concluded that both a strong safety culture and positive safety behaviour have a favourable impact on safety performance (Yung Hsiang, 2011). This suggests that an organisational culture that actively promotes safety and is supported by concrete actions can have positive effects on accident prevention and worker protection. On the other hand, in the US nuclear power industry, a research found an empirical relationship between safety culture and safety performance (Morrow et al., 2014). This study argues that a strong safety culture, supported by effective policies and practices, can contribute to improve safety performance in high-risk environments. Recently, a comparative qualitative study was conducted in the construction sector with the aim of analysing the relationship between twelve safety management factors and safety performance. As a result, eight factors were identified as necessary to achieve high safety performance (Winge et al., 2019). This study provides valuable information to understand how different aspects of safety management can influence performance and how they can be improved.

Collectively, these studies express the need to develop and promote a strong safety culture within organisations. By taking a socio-technical approach and considering multiple factors, these studies contribute to our understanding of how safety culture impacts worker performance and protection. These findings underscore the importance of implementing effective safety management practices to improve safety performance research.

Accordingly, we hypothesise the following:

**(1) Hypothesis 1.** Safety culture improves safety performance.

By working on safety culture, the organisation is working on its organisational principles, working conditions, quality, and dialogue. A manager's attitude in preventive matters will be the basis for the behaviour of employees and therefore for the results of the organisation (Clarke, 1999). An essential role can be played by the managers whose knowledge, experience, and leadership traits have the greatest impact on the financial success of an organisation (Markowski et al., 2021).

Practices related to OHS have been shown to positively impact company performance (Black and Lynch, 2001). It is suggested that the more positive the firm's safety attitude, the lower the number of

accidents and the higher the productivity of workers (Rundmo, 2000), which will have a positive impact on financial performance. Other authors also argue that there is a positive relationship between safety climate and business performance. Through a cross-sectional study, they concluded that safety performance has a positive effect on a firm's performance (Kundu et al., 2016). Boles et al. (2004) suggest that a good working environment leads to improved company performance and Bourne et al. (2002) argue that a positively perceived safety climate favourably influences safety performance and thus financial performance. Results from previous research in the motor carrier sector indicate a favourable relationship between safety performance and business performance (Britto et al., 2010). Also within the manufacturing sector, a qualitative and cross-sectional research of Canadian firms (Hajmohammad and Vachon, 2014) demonstrates improved performance in organisations with a positive safety culture. In this work, organisational performance is defined following three dimensions: environmental performance, safety performance and financial performance. Accordingly, companies wishing to improve their financial and environmental performance should focus on safety and employee participation and engagement.

Therefore, we pose the following hypothesis:

**(2) Hypothesis 2.** The better the safety performance, the better the firm's performance.

### 3. Methods

#### 3.1. Data and sample

The research setting for this study is a dataset of European companies from all sectors of activity, listed in Thomson Reuters Refinitiv ESG scores, that are consistently rated for the Environmental, Social and Governance (ESG) performance, for a period of fourteen years, from 2005 to 2019. Information for this database was updated in March of 2021. In recent years, European policies for OHS and the protection of workers have become stricter by reinforcing existing legislation, creating new standards on Occupational Health and Safety management systems such as ISO 45001 (ISO, 2018), or ISO 26000 of Corporate Social Responsibility management systems (ISO, 2010) and, even offering workers more flexible measures for a work-life balance. These policies increase workers' satisfaction, which may have an impact on a company's performance and profits (Pan et al., 2014). This explains why the European context represents a suitable research setting in which to explore the consequences of safety culture and safety performance.

Thomson Reuters Refinitiv represents one of the most comprehensive ESG databases. It comprises relevant quantitative and qualitative company-level data on public companies worldwide over several years, making it an excellent source of data for longitudinal studies (Refinitiv, 2021). Noteworthy research employs this database (Arayssi et al., 2020; Shakil et al., 2020), which calculates ESG Scores previously designed by analysts to transparently and objectively measure a company's relative ESG performance, commitment and effectiveness across ten main themes (Refinitiv, 2021).

We identified an initial population of 1921 companies. 829 firms out of them (43%) have available information on the total injury rate, one of the main variables of our model. Considering data availability constraints, our final sample includes an unbalanced panel of 829 European public firms, and the total number of observations is 3606. The sample comprises firms from a total of 29 European countries from all activity sectors. The most representative countries are: United Kingdom (21%), France (10%), Italy (10%) and Germany (8%). The most significant sectors of activity are: lessor of real estate (6.68%), depository credit intermediation (6.28%), pharmaceutical and medicine manufacturing (3.27%), electric power (generation, transmission and distribution) (3.66%), architectural, engineering and basic chemical manufacturing (3.27%), agriculture, construction and mining machinery manufacturing (1.44%), aerospace product and parts manufacturing

(1.31%).

This study uses a regression model OLS that includes fixed effects to test the hypotheses. Software STATA was used to perform the statistical analysis.

#### 3.2. Measures

##### 3.2.1. Dependent variables

To test hypothesis 1, we measure safety performance through the dependent variable "total injury rate". This also represents the independent variable to test hypothesis 2. It is measured through an indicator reported by the ESG database using the same name. It is a continuous variable and is defined as the total number of injuries and fatalities including no-lost-time injuries relative to one million hours worked. The lower the total injury rate, the higher the safety performance.

The second dependent variable used to test hypothesis 2 is "firm's performance". To measure this variable, we use EBITDA (earnings before interest, taxes, depreciation and amortization). This measure reflects the firm's liquidity. In previous research, it has been considered as an appropriate measure of financial performance, as it has been repeatedly mentioned in the annual reports of numerous listed companies (Miller and Saldanha, 2016). We employ a logarithmic transformation of EBITDA to account for its skewed distribution, it is widely used in business and is highly relevant to business performance (Valeur, 2021).

Indicators based on lost time injury rates may be considered unreliable (Kjellén and Albrechtsen, 2017). Particular caution should be exercised when using common safety and health indicators as they can be misinterpreted, and some authors claim that they may be unreliable (Oswald et al., 2018). The total injury rate is considered to be one of the best reliable quantitative indicators of safety performance. It is more robust than the lost time injury rate since total injury rate reflects a larger number of injuries which may be closer to real data (Winge et al., 2019).

##### 3.2.2. Independent variable

"Safety culture" is the independent variable to test hypothesis 1 and is an indicator constructed from the sum of the following six dichotomous variables (measured as 0 and 1) drawn from the ESG database:

- Policy Employee Health and Safety: Does the company have a policy to improve employee health and safety? The elaboration of a safety policy includes the organisation's commitment to occupational safety and reflects the objectives to be followed and guidelines in preventive matters (Fernández Muñoz et al., 2009). The European Commission, in the EU Strategic Framework on Health and Safety at Work 2021–2027, suggests that promoting cooperation and coordination of OHS policies is one of the main areas of interest for future framework (European Commission, 2001).
- Policy Supply Chain Health & Safety: Does the company have a policy to improve employee health & safety in its supply chain? Preventive initiatives are carried out to improve safety conditions in the supply chain. Some authors argue that it is important to consider the involvement of employees, otherwise there could be negative consequences for workers' safety (Bhattacharya and Tang, 2013). Workers in the supply chain are sometimes subjected to working conditions under pressure that could seriously affect their health without proper OHS management (Jermisittiparsert et al., 2019).
- Employees Health & Safety Team: Does the company have an employee health & safety team? This team is important to motivate and encourage workers to participate in activities and other aspects related to OHS (Fernández Muñoz et al., 2009).
- Health & Safety Training: Does the company train its executives or key employees on health & safety? A key factor in safety culture is the training of employees to improve their skills to reduce risks and



prevent accidents at work. The main objective of training is to minimise the number of accidents at work and occupational diseases. Employees can acquire experience by being trained and by analysing real accident cases (Tengilimoglu et al., 2016). Managers have an obligation to train workers and to inform them about the risks inherent in the work they do. Some authors show that the level of safety culture and safety performance increases in those workers who have received safety training and in those workers who have considered this information to be sufficient (Tengilimoglu et al., 2016).

- **Supply Chain Health & Safety Training:** Does the company train its executives or key employees on employee health & safety in the supply chain? Firms in the supply chain could pay less attention to the safety and health of their workers and therefore face problems regarding preventive behaviour (Jermisittiparsert et al., 2019). In this sense, supply chain health & safety training is a fundamental aspect.
- **Employees Health & Safety OHSAS 18001/ISO 45001:** Does the company have health & safety management systems in place such as OHSAS 18001 or ISO 45001. The higher the degree of development of the organisations' safety and health management systems, the better the safety culture. An efficient health and safety management system must contain a prevention policy that recognises the values and principles of the organisation in preventive matters, encourages the participation of workers in health and safety activities, promotes communication concerning risks and associated preventive measures, carries out training activities for workers, plans the necessary tasks for accident prevention and monitors all preventive activities that occur (Fernández Muñoz et al., 2007).

The development of a safety culture policy must be based on measurements that allow us to know the degree of development and to evaluate changes over time (Arias Botero and Gómez Arias, 2017). In our study, the dependent variable "safety culture" can take value 0, when the firm does not implement any of the initiatives indicated above and up to value 6, when the firm implements all of them.

### 3.2.3. Control variables

We control for several variables that could affect the causal relationships explored in this study.

We control for the size of the company with the variable called "LogSize", that is defined as the logarithm of the number of employees. This logarithmic transformation is used to consider its skewed distribution. The firm size could influence the number of accidents, since large companies have more safety knowledge than small companies (Reniers et al., 2005).

Another control variable is "ESG combined score" which reflects the level of CSR implemented by the firm. CSR contributes to improving the quality of life of workers, the community and society in general. In order to apply CSR in companies, the commitment of managers, innovative thinking, more participations of workers and their representatives is needed (European Commission, 2001). Some research refers to the concept of CSR as seen from two approaches; an internal approach, understood as the effort an organisation makes towards its employees in terms of occupational safety, and an external approach, understood as the organisation's effort towards workers in the supply chain (Koskela, 2014), local and global actions made up of the actions of the supply chain itself, actions in the local community and actions to maintain product safety (Zwetsloot et al., 2004). With regard to Internal Social Responsibility, there is evidence that socially responsible companies generate greater employee engagement, more creative employee participation and improve labour relations (Aguinis and Glavas, 2012).

The ESG combined score is obtained from the ESG database and is based on the reported information from the environmental, social and corporate governance pillars (ESG Score) with an ESG Controversies overlay. ESG Scores provide insight into the commitment, performance and the operations of companies of different sizes. The value of this

indicator ranges from 0 to 100, where 100 corresponds to the highest performance (Refinitiv, 2021).

"CSR strategy" has been included as a control variable that can more accurately explain corporate reputation in the robustness check. This variable is a score reported by the ESG database and measures how well the company communicates the integration of social, environmental and financial dimensions into decision-making processes. Investors and stakeholders need to know how companies are managed. Disclosure of information on CSR practices in companies is increasingly integrated into annual financial reporting and could influence the decision-making process (Formigoni et al., 2021) which would also have a positive impact on corporate reputation (Pérez, 2015). This variable is measured on a range from 0 to 100, with 100 being the highest performance value.

We also include "quality management systems" as a control variable, a score reported by the ESG database. It is dichotomous and takes value 1 if the company claims to apply quality management systems such as ISO 9000, Six Sigma, Lean Manufacturing, Lean Sigma, Total Quality Management (TQM) or any other similar quality principles, and 0 otherwise. Promoting employee participation and decentralising preventive decision-making could support the effectiveness of a safety management system (Mohammadfam et al., 2016). The objective of quality control is to eliminate defects to improve product quality, just as safety control will reduce the number of injuries to eliminate unsafe working conditions (Loushine et al., 2006). Hence, safety can be supported by quality management (Dumas, 1987).

### 3.2.4. Robustness analysis method

Several robustness checks have been carried out to verify if the results are stable. How results might vary using alternative specifications of the independent, dependent and control variables have been explored. "Safety culture (dummy)" has been used as an alternative measure to test hypothesis 1 and "reputation" has been used as an alternative measure of the firm's performance to test hypothesis 2. Safety culture dummy can take value 1 when firms implement the six initiatives which make up the safety culture variable and 0 otherwise. Furthermore, instead of the ESG combined score, we used "CSR strategy" as an alternative control variable to test hypothesis 1. CSR strategy measures how well the company communicates to stakeholders (included employees) the integration of social, environmental and financial dimensions into decision-making processes. Such communication may have an effect on the proper implementation and development of safety culture.

We run additional analyses to identify the most influential parameters within the process. We estimated two separate models for the two components of total injury rate: total injury rate of employees and total injury rate of contractors. These alternative dependent variables were measured through an indicator reported by the ESG database with the same name. To explain total injury rate of employees we include the initiatives of safety culture related to employees in the model. For total injury rate of contractors, we used the initiatives related to the supply chain (see Section 3.2.2).

The variable "reputation" is measured through the social pillar score included in the ESG database defined as: "a company's capacity to generate trust and loyalty with its workforce, customers and society, through its use of best management practices. It is a reflection of the company's reputation and the health of its license to operate, which are key factors in determining its ability to generate long term shareholder value". To calculate this score, indicators such as product responsibility, workforce, human rights or community based on 63 indicators are considered.

OLS regressions have some limitations. Fixed-effects estimates may be inefficient, possibly inflating standard errors (Allison, 1996). Since we have used robust variance estimators and the Heckman two-step method, concerns regarding biased and inefficient estimates are reduced. We have a panel data of firms. Fixed effects regressions produce estimators that deal with unobserved heterogeneity at cluster level,

but at the expense of dropping all observations from clusters with no events. Random effects estimators consider all the observations, but they do not adequately account for unobserved heterogeneity at the group or cluster level. As a sensitivity analysis, we used GEE specification that overcomes the mentioned limitations since it is both efficient and accounts for unobserved heterogeneity reducing endogeneity concerns (Krishnan and Kozhikode, 2015). Additionally, we conducted alternative specifications of the main independent variables to check if the causal relationships are non-linear. To examine a potential nonlinearity, we fit a model that included the quadratic effect of safety culture to test hypothesis 1, and another model using the quadratic effect of total injury rate to test hypothesis 2.

#### 4. Results

##### 4.1. Descriptive statistics and regression results

Descriptive statistics of the variables under study (mean, standard deviation and correlations) are shown in Table 1.

Observing the development of safety culture, firms exhibit an increasing implementation over time. In 2006, only 1 firm had adopted the combination of the six initiatives related to safety culture. In 2005, 5 companies were identified to apply five initiatives, but no company had implemented all initiatives in a comprehensive way.

However, in 2019, 263 out of the 829 firms (31.72%) had developed an integral approach to safety culture based on the implementation of the six strategies. In our sample, the mean number of employees is 18,753 and 197 firms that have <250 employees.

Table 2 reports the results of the ordinary least squares (OLS) regressions with fixed effects examining how safety culture influences safety performance. Firm fixed effects account for firm specific characteristics that can shape safety performance. This model suggests that the differences between the units of analysis could be accommodated from different intercepts (Zulfikar, 2018). It is prudent to assume that the errors might be heteroscedastic. To ensure valid statistical inferences, we used robust variance estimators, which controlled for errors not distributed identically across firms (Petersen, 2009).

The relationship between safety culture and total injury rate may suffer from endogeneity. In dynamic panels, the independent variables may be potentially endogenous because they may be correlated to error terms across time if they are not strictly exogenous. Endogeneity can also occur for several reasons, including omitted variables, selection bias, reverse causality, among others (Wolfolds and Siegel, 2019). We employed the Heckman two-step method (Heckman, 1979) to address the potential problem of endogeneity. We estimated the first-stage equation as an independent probit model to predict whether firms had pursued safety culture, and when the vector of independent variables included size, ESG combined score and quality management systems. The inverse Mills ratio generated in the first-stage probit regression was included in the second-stage regression to adjust for potential endogeneity (results available under request). The inverse Mills ratio is not significant in the model specification, so there is no potential endogeneity problem and we maintained the original analyses (shown in Table 2).

**Table 1**  
Summary of descriptive statistics.

Variable	Mean	Std. dev.	1	2	3	4	5	6	7
1 Total injury rate	8.55	25.21	1.00						
2 Firm's performance	20.40	1.55	-0.10****	1.00					
3 Safety culture	2.38	2.08	-0.04*	0.06***	1.00				
4 LogSize	9.30	1.62	-0.03	0.70***	0.05***	1.00			
5 ESG combined score	55.31	16.12	-0.04*	0.36***	0.08***	0.33***	1.00		
6 CSR strategy	54.46	28.22	-0.05***	0.44***	0.07***	0.32***	0.50***	1.00	
7 Quality management systems	0.61	0.48	0.04**	0.09***	0.04*	0.17***	0.19***	0.04**	1.00

\*\*\* p < 0.001; \*\* p < 0.01; \* p < 0.05.

We introduced the control variables in the first step (see Model 1). The dependent variable, "safety performance", was added to the equation in Model 2.

We tested our data for multicollinearity. The variance inflation factor (VIF) is a measure of the reciprocal of the complement of the intercorrelation among the predictor variables: variance inflation factor  $VIF = 1/(1 - r^2)$  where  $r^2$  is the multiple correlation between the predictor variable and the other predictors. Variance inflation factor values greater than 10 indicate possible problems (Cohen, Cohen, West, & Aiken, 2003). Regarding Models 1, 2 and 3 (Table 2), the highest variance inflation factor score was 3.53, which was within acceptable parameters, and the highest mean of variance inflation factor was 2.74.

Hypothesis 1 is accepted since there is a negative and significant relationship between safety culture and total injury rate ( $b = -0.298$ ,  $p < 0.01$ ).

When examining the effect of the control variables, the importance of the ESG combined score variable in the models presented in Table 2 is evident. The implementation of CSR provides a support that benefits OHS.

Table 3 shows the results of the OLS regressions with fixed effects examining how the total injury rate influences a firm's performance. Including control variables in our regression models and applying a fixed effect regression technique is useful to account for other firms' factors that may explain variations in EBITDA. As we did previously, we used robust variance estimators to control for heteroscedasticity. Moreover, we employed the Heckman two-step method (Heckman, 1979) to address the potential endogeneity. In this case, the estimated inverse Mills ratio is statistically significant, so we show the estimation of the corrected model in Model 2 (Table 3). We introduced the control variables in the first step (Model 1). We checked for multicollinearity by calculating the variance inflation factor (VIF) scores for all the variables in the models, which were within acceptable ranges (all less than six).

The independent variable total injury rate was added to the equation in Model 2 given the variance counted. There is a negative and significant relationship between the total injury rate and the firm's performance ( $b = -0.003$ ,  $p < 0.01$ ). Therefore, hypothesis 2 is confirmed.

##### 4.2. Robustness checks

The sensitivity analysis using the alternative measure of safety culture as a dummy variable (see Model 3 in Table 2) confirms the results obtained. Having a comprehensive safety culture, implementing all practices, has an even greater effect on reducing the total number of accidents. The robustness check regarding CSR strategy as a control variable (see Model 4 in Table 2) also confirms hypothesis 1.

Going deeper into the study of the most influential parameters, we found that to reduce the total injury rate of employees, the most relevant initiatives are having an employee health and safety team ( $b = -80.866$ ,  $p < 0.05$ ), and health and safety management systems in place such as OHSAS 18001 or ISO 45001 ( $b = -1.040$ ,  $p < 0.01$ ). Having a policy to improve employee health & safety in a firm's supply chain is the most influential initiative to reduce the total injury rate of contractors ( $b = -81.671$ ,  $p < 0.01$ ).

There is empirical evidence to ensure that the adoption of the OHSAS

**Table 2**  
OLS regression results on safety performance.

	Model 1 Total injury rate (only control variables)		Model 2 Total injury rate		Model 3 Total injury rate		Model 4 Total injury rate	
Safety culture			-0.298**	(0.101)			-0.305**	(0.091)
Safety culture (dummy)					-1.09**	(0.341)		
LogSize	-0.008	(0.616)	-0.005	(0.607)	-0.008	(0.615)	-0.059	(0.350)
ESG combined score	-0.047***	(0.014)	-0.042***	(0.015)	-0.042**	(0.014)		
CSR strategy							-0.018**	(0.006)
Quality management systems	-0.678	(0.399)	-0.649	(0.394)	-0.639	(0.397)	-0.810*	(0.363)
Constant	11.669*	(5.720)	12.041***	(5.686)	11.513*	(5.708)	11.350***	(3.254)
R <sup>2</sup>	0.01		0.01		0.01		0.01	
F	6.91***		7.13***		7.42***		8.21***	
Number of firms	829		829		829		829	
N (firm-year observations)	3606		3605		3606		3605	

Robust standard errors are in parentheses.

\*\*\* p < 0.001; \*\* p < 0.01; \* p < 0.05.

**Table 3**  
OLS regression results on firm's performance.

	Model 1 Firm's performance (only control variables)		Model 2 Firm's performance		Model 3 Reputation	
Total injury rate			-0.003**	(0.001)	-0.291***	(0.062)
LogSize	0.623***	(0.041)	0.691***	(0.084)	1.525	(1.193)
CSR strategy					0.243***	(0.019)
Inverse Mills ratio ( $\lambda$ )			1.446***	(0.288)		
Constant	14.294***	(0.352)	14.039***	(0.782)	37.696***	(10.913)
R <sup>2</sup>	0.50		0.48		0.18	
F	229.91***		162.48***		69.38***	
Number of firms	814		814		829	
N (firm-year observations)	3303		3303		3605	

Robust standard errors are in parentheses.

\*\*\* p < 0.001; \*\* p < 0.01; \* p < 0.05.

18001 or ISO 45001 standards positively influences occupational safety (Hamidi et al., 2012). Companies that have an Occupational Health and Safety Management System implement compliance-oriented actions to ensure a safe working environment (Minchán Yopla and León Fernández, 2022). These actions include conducting risk assessments to identify and mitigate risks in the workplace, performing internal audits to assess the effectiveness of the management system and the introduction of improvements or the implementation of emergency procedures and contingency plans in risk situations (Vinodkumar and Bhasi, 2011). In this regard, Wiengarten et al. (2017) claim that the perception of safety performance is higher when the key supplier is also OHSAS 18001 certified.

Having an occupational health and safety team in workplace will allow developing and implementing safety and health policies and procedures in the organisation, as well as investigating accidents, which will contribute to the promotion of safety culture throughout the organisation and to maintain open communication by encouraging workers' participation and engagement (Guennoc et al., 2019).

Related to policies to improve the occupational health and safety of employees in the supply chain, the company could undertake the following actions: (1) foster collaboration and accountability among the different actors in the supply chain by ensuring a safe working environment; (2) provide training and guidance to suppliers on safe practices, as well as promote transparency in the supply chain, including the disclosure of information on implemented safety and health policies and practices (Duryan et al., 2020).

Table 3 exposes the results from the sensitivity check related to hypothesis 2. Model 3 in Table 3 uses the alternative measure of the dependent variable and includes CSR strategy as a control variable since it is considered that reputation is influenced by the firm's CSR communication strategy. The results demonstrate that a reduction in accidents at work improves the reputation. An increase in workplace

accidents has a significant negative impact on company reputation (Wang et al., 2006).

The robustness check using GEE specification to overcome potential limitations of the OLS regression produces similar results (available upon request) and confirms both hypothesis 1 and 2. Regarding the sensitivity analysis to examine nonlinearity of the causal relationships of hypotheses 1 and 2, our findings show neither the quadratic effect of safety culture nor that of the total injury rate have a statistically significant effect.

The robustness tests corroborate the relationship among safety culture, safety performance and a firm's performance, and therefore support the main findings of this study.

## 5. Discussion

Safety management is made up of the set of practices that are developed by organisations with the aim of minimising risks in the workplace and therefore accidents. To achieve this purpose, it is necessary to involve workers, who must be aware of the importance of safety at work and act accordingly.

Safety culture cannot be dissociated from the general organisational culture of the company and the latter can only be conceived as a dynamic concept that is generated through the interactions between the different members of the organisation (Arévalo Sarrate and Jaén Sánchez, 2018). The overall organisational culture of companies plays an important role in building resilient organisations. The concept of organisational resilience is crucial and encompasses numerous and divergent issues. The combination of resilience as a process and the idea of resilience as a unique combination of organisational capacities and routines generates a comprehensive understanding of the phenomenon of resilience in organisations (Sydow et al., 2009). Understanding these aspects is fundamental to promote the emergence of organisations and

their ability of facing and recovering from challenges and opportunities.

In this regard, [Bragatto et al., \(2021\)](#), define “organisational resilience” as the ability of an organisation to anticipate, prepare, respond and adapt to incremental changes and sudden disruption. In a recent study, four different phases are addressed, with apparently contradictory perspectives as they divide organisational resilience between defensive behaviours (avoiding bad things happening) and progressive behaviours (making good things happen): (1) preventative control, (2) mindful action, (3) performance optimisation and (4) adaptive innovation.

Organisational tensions arising from different management perspectives are the result of divergent approaches and values within an organisation. These tensions are particularly apparent related to safety culture, its implementation and the commitment required from management teams.

A preventive culture involves fostering a mindset of anticipation and risk prevention within the organisation. However, different management perspectives can create tensions in this regard. For example, the preventative control approach (defensive consistency) is achieved through risk management, physical barriers which protect the organisation from threats. This might prioritise risk minimisation and strict adherence to established procedures, but it might also limit the organisation’s ability to adapt and innovate.

Regarding mindful action (defensive flexibility), it would help to identify and react to potential threats or risks and respond to them in an effective way. Additionally, optimising performance (progressive consistency) could increase pressures to achieve ambitious goals and results, which could lead to neglecting preventive aspects for the sake of efficiency and productivity. On the other hand, the adaptive innovation perspective (progressive flexibility) may focus on the constant search for new solutions and approaches, which might clash with safety culture if risk management is not adequately considered. These organisational tensions require the commitment of management teams to address them effectively. Management commitment to safety is generally recognised as a crucial aspect of successful safety performance ([O’Dea and Flin, 2001](#); [Rundmo and Hale, 2003](#)). Previous research suggests that the greater the degree of commitment by the management, the greater the involvement of employees. This is a fundamental aspect of accident prevention if we consider that previous studies confirm that between 85% and 98% of injuries at work are due to the human factor (unsafe acts) ([Fernández Muñiz et al., 2007](#)). Barriers can include resistance to change, a lack of clarity in roles and responsibilities, and a lack of communication and alignment between different management perspectives. Overcoming these barriers involves fostering a culture of openness, collaboration and mutual understanding, where the benefits of a safety culture are recognised, and solutions are sought that effectively integrate different management approaches in a balanced way.

Currently, the number of accidents produced in the workplace is still very high and these involve a cost to organisations and society in general whether in terms of workers’ compensation, lost working hours or legal costs. Thus, investing in safety can help avoid these costs ([Ma et al., 2016](#)). Theoretically, this may seem like common sense, but in practice, however, it is not implemented. There could be a disconnection between theoretical knowledge of safety best practices and their practical implementation in the workplace. Sometimes, employees may be trained in safety, but may neglect its implementation due to lack of supervision or pressure to meet deadlines and work goals.

Recognising that the prevention of risks at work involves taking proactive measures is important to avoid accidents and injuries in the workplace. This includes implementing robust safety policies, providing adequate training for employees, and creating a safe work environment. This should lead to a decrease in accidents and an increase in safety. However, high accident rates show that safety culture has not yet completely taken root in many companies. This may be due to several factors, such as lack of awareness of occupational hazards, lack of resources dedicated to safety or lack of monitoring and enforcement of

existing safety measures.

The process of evolution of safety culture covers several stages. A first stage can be distinguished in which safety is perceived as something imposed by management and not as something inherent to the company’s operating cycle. Therefore, those companies that consider safety as a cost, could fall into this stage. ([Arévalo Sarrate and Jaén Sánchez, 2018](#)). A clear example of this is produced in the construction sector, where there is a real imbalance between cost and safety. Reality shows that many companies still do not invest enough in safety culture in order to save money in the short term. Many companies do not invest in safety because they consider it costly and neglect safety investment, which increases their vulnerability and exposes them to higher risks and unforeseen expenses ([Oswald et al., 2020](#)). Another aspect to consider is resistance to change. Some companies may be entrenched in a reactive culture, where they focus more on correcting problems after they occur rather than preventing them. Changing this mindset requires time, effort and a strong awareness of the long-term benefits of a safety culture.

Our research reinforces that promoting safety culture is a benefit, a strategic investment, not an additional cost, and concludes that safety not only protects a company’s assets but also improves its overall performance. Investing in safety is an intuitive and long-term investment that not only reduces costs, but also safeguards the company’s success and reputation.

## 6. Conclusion

This research expands on the scant previous contributions by examining the relationship between safety culture and safety performance through a quantitative and longitudinal approach. It confirms that safety culture improves safety performance since it significantly reduces the number of accidents at work, which is in line with previous research ([Feng et al., 2014](#); [Kalteh et al., 2019](#); [Kundu et al., 2016](#)). We demonstrate that the development of a positive safety culture based on policies that improve the safety and health of workers in the firm and within the supply chain, that promotes training among its employees, including managers, or that is based on the implementation of OHS management systems all benefit the safety performance of an organisation.

By examining a panel data of European firms, we support that safety culture reduces the total injury rate. There is evidence concluding that a change in the organisational culture could allow a change in the trend in injury rates ([Cooper, 2000](#)). Organisations should strive to ensure good safety culture and contribute to increasing levels of job satisfaction by promoting safe practices, training and the participation of workers in OHS councils. In this respect, [Tengilimoglu et al., \(2016\)](#) agree that companies and workers should promote safety culture in their organisations.

We also find that the better the safety performance, the better the firm’s performance. This research provides evidence that both safety culture and safety performance, as measured by total injury rate, are positive predictors of a company’s financial performance. If labour accidents are reduced, the company’s profitability improves. These results are consistent with previous works ([de Sousa et al., 2021](#)).

Improving the safety culture of organisations is beneficial for financial performance, and also enhances corporate reputation ([Hajmohammad and Vachon, 2014](#)). A consolidated reputation is a key factor to reach and maintain for a competitive advantage ([Bergh et al., 2010](#); [Walker, 2010](#)). In accordance with our results, recent research has conducted a literature review considering the relationship between companies investing in occupational safety and their financial performance from 1945 to 2018 and concludes that companies that invest in OHS have a better financial performance than those that do not ([de Sousa et al., 2021](#)).

The present research has implications for theory. It contributes to the literature on safety culture. We consider a comprehensive set of initiatives regarding safety culture and explore the relationship between



different areas of research, demonstrating that safety culture has an impact on safety performance. We also extend previous literature aimed at analysing the effects of safety performance on a firm's financial results (de Sousa et al., 2021). In a complementary way, this research contributes to the literature on CSR strategies and policies accomplished by companies and their employees, which not only lead to the reduction of accidents at work but also have an impact on financial performance (Pan et al., 2014).

This research also provides valuable information that could be of help in decision-making processes for managers. Investment in safety is included in this category (Miller and Saldanha, 2016). Managers need to foster the mindset that financial performance and safety are complementary objectives (Pagell et al., 2015). Their engagement and leadership have been identified as the most decisive factor regarding the management and organisational factors that have an impact on corporate safety indicators (Markowski et al., 2021). They should consider that investing in safety will have a favourable effect on the financial performance of the organisation and our findings provide them with empirical evidence. Moreover, our results offer a guideline to establish specific actions that managers may undertake since we identify different influential initiatives to improve the safety performance in the firm on the one hand and to ameliorate the safety performance within the supply chain on the other hand. We found that to enhance safety performance in a firm, reducing the total injury rate of employees, the most relevant initiatives are having an employee health and safety team and health and safety management systems in place such as OHSAS 18001 or ISO 45001. Whereas to reduce the total injury rate of contractors, the most influential initiative is having a policy to improve employee health and safety in a firm's supply chain.

This research offers consistent and robust results with relevant implications for regulators and policy makers who could actively intervene by modifying regulations and increasing safety policy incentives (Gunningham, 1999). In particular, our results suggest that an incentive-based approach may be followed to persuade firms not only to promote the adoption of OHS systems but also to create and maintain an employee health and safety team or to encourage firms to develop a policy with preventive initiatives to improve safety conditions in the supply chain.

We must acknowledge some limitations that encourage us to undertake future research. The use of dummy variables to measure strategies involved in safety culture provides information on whether or not companies carry out each of the practices. The initiatives involved in the strategies are complex, and companies may implement them to varying degrees. Additionally, the indicators used in the safety culture variable are policy and/or management focused, and some initiatives could not actually be extended to workers.

Furthermore, in relying extensively on secondary data, our results are subject to possible measurement errors and biases that we cannot accurately quantify and evaluate. We feel confident about the basic validity of our results despite the possible biases arising from this source because of the estimation methods used and our robustness checks. Future research could deepen the relationships explored by complementing them with primary sources such as questionnaires addressed to companies to study how the different levels of implementation, regarding each initiative, influence the safety performance of the company. Using such sources may also be useful to address potential biased estimators, and help overcome limitations of the secondary data used such as a possible underrepresentation of sectors with higher rates of safety incidents (e.g., agriculture, forestry, fishing, mining, food processing, and transportation).

We studied a panel of European companies. Extending the present study to other non-European countries could benefit future research. Although the number of accidents used as a measure in our study is highly relevant, we have not considered measures of psychosocial risk indicators, which have mainly increased as a result of the Covid-19 pandemic (Hernández Rodríguez, 2020) or measures of occupational

disease indicators that would be interesting to consider and that would support the premise that health and economic issues are interdependent aspects (Gaies, 2022). It is possible that other variables that have not been contemplated in this research could also explain the results of this research, for example, variables related to lost time rate, absenteeism or occupational diseases. It would also be interesting to explore other drivers of safety culture and firm performance since some of the control variables considered have turned out not to be significant, such as size. This could mean that larger companies may have more "safety knowledge", but knowledge does not always translate into behaviour. Beyond leadership and policy, the role of a worker's involvement in the development of a firm's safety culture needs to be addressed. It is necessary to be cautious with other control variables such as CSR. It has a significant effect on safety performance but it could be implemented more as a public relations strategy as the results regarding reputation demonstrate.

Our research further develops the understanding of the relationship between safety culture and performance and financial results, and has theoretical and managerial implications. The results obtained encourage further study of some issues that have not been addressed, for example, exploring the consequences of the different levels of implementation of each safety culture strategy and considering additional indicators of safety performance. These constitute promising streams for future research.

#### CRediT authorship contribution statement

**Irene Bautista-Bernal:** Investigation, Validation, Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Visualization. **Cristina Quintana-García:** Validation, Methodology, Software, Formal analysis, Investigation, Resources, Data curation, Writing – review & editing, Supervision, Project administration. **Macarena Marchante-Lara:** Investigation, Validation, Conceptualization, Methodology, Resources, Writing – review & editing, Supervision, Project administration.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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