Universitat de les Illes Balears

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# THREE ESSAYS ON THE RELATIONSHIP BETWEEN PREVENTIVE TRAINING, ACCIDENTS AND FIRM PERFORMANCE

Bàrbara Estudillo Gil

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**Doctoral Programme in Economics, Management and Organization (Business Economics)**

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**Doctor by the Universitat de les Illes Balears**

In memory of my beloved father,

I would love for you to be here. Without your inspiration, I could not have done it.

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# Thesis modality.

Present Ph.D. thesis is presented under the modality of a compendium of articles. The three articles that conform present thesis and the authors' references are listed below. All of they have fulfilled the duties of the corresponding Ph.D. program.

First article:
Effectiveness of training in reducing accidents in construction companies
Bàrbara Estudillo Gil, Doctoring
Jose M. Carretero-Gómez, Ph.D. Business Economics Department, Balearic Islands University
Francisco J. Forteza Oliver, Ph.D. Department of Engineering and civil Construction, Balearic Islands University

Second article:
When do accidents affect the company's profitability?
Bàrbara Estudillo Gil, Doctoring
Jose M. Carretero-Gómez, Ph.D. Business Economics Department, Balearic Islands University
Francisco J. Forteza Oliver, Ph.D. Department of Engineering and civil Construction, Balearic Islands University

Third article:
Why is the construction sector failing in protecting its workers' health?
Bàrbara Estudillo Gil, Doctoring
Jose M. Carretero-Gómez, Ph.D. Business Economics Department, Balearic Islands University
Francisco J. Forteza Oliver, Ph.D. Department of Engineering and civil Construction, Balearic Islands University
Francisco Rejón Guardia, Ph.D. Department of Economics and Business Administration. University of Malaga.

# Thesis supervision certificate

Universitat de les Illes Balears

Dr. José María Carretero Gómez and Dr. Francisco José Forteza Oliver, from the Universitat de les Illes Balears

WE DECLARE:

That the thesis entitled "Three essays on the relationship between preventive training, accidents and firm performance", presented by Bàrbara Estudillo Gil to obtain a doctoral degree, has been completed under our supervision.

For all intents and purposes, we hereby sign this document.

Signature

Palma de Mallorca, July 2022

# Co-authors agreements

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# Abstract

Occupational accidents are one of the most severe problems for workers' health worldwide, especially in dangerous sectors such as the construction sector. In this context, we analyze some individual and organizational factors that companies can manage to reduce this high number of accidents and protect their workers' health. This study focuses on the construction sector, one of the sectors that most have to deal with accidents and their consequences.

Firstly, we focus on workers' safety training. We examine whether safety training reduces accidents in the construction sector. Using data from the training providers companies, the Spanish Labor Authority, and Informa & Bureau van Dijk (SABI), we analyzed this relationship from 1283 construction companies' data over 11 years (2007—2017). Our results show that more hours of safety training are associated with more accidents. The results also show that just the continuous compulsory training provided by qualified entities led to a reduction in accidents, thus indicating a practical implication to reviewing the actual safety training.

These occupational accidents directly affect the human resources of a company and its productivity. Despite this, there is still a scarce safety culture within the companies in this sector and insufficient knowledge of the effects these high accident rates have on the company results. Previous studies that focus on the relationship between the accident rate and the company's profitability found mixed evidence. We hypothesize that accident rates impair the company's profitability. And that the effect changes depending on accident rate levels, the company's profitability increases for low levels of accidents, while it is reduced for high levels of accidents. Our results show that the accident rate does not reduce the company's profitability. However, supporting the latest hypotheses, an inverted U-shape is confirmed, with the maximum profitability at a certain level of the accident rate. We conducted the analyses using pooled, random, and fixed-effect estimators. In addition, we have conducted the U-test and the Fieller test to confirm the shape it has. Furthermore, we have used dynamic panel data estimation to control for endogeneity, derived from the possibility that the current values of some of the independent variables are a function of past company performance.

Following the analysis of the factors that a company can manage to reduce its accidents and protect its workers' health, we focus on analyzing the safety climate. One of the main aims of this work is to propose a theoretical model to measure the direct and indirect effect of safety climate on workers' physical and mental health mediated by job satisfaction. Since the literature has not provided a widespread model that can reflect the safety climate for different industries and companies. We propose a multidimensional construct of safety climate, considering the most salient factors in the literature and including psychological capital as a new factor that affects the workers' perception of safety climate. Job satisfaction includes working conditions, job rewards and compensations, and work-life balance. In this last part of the study, we used the last wave of the European Working Conditions Survey (2015), which has data from the construction sector in Spain. The proposed model was validated by using structural equation modeling. Our results highlighted that to improve mental health in construction workers, it is necessary to emphasize the importance of work-life balance, job rewards and compensations, and safety climate. As for physical health, it is crucial to control both safety climate and work-life balance. Eventually, we present some recommendations to construction companies' managers, letting them know the different items that have to be controlled to improve their results by establishing a ranking of all the variables that explain safety climate.

**KEYWORDS:** Training; construction sector; accidents; companies; profitability; GMM estimation, safety climate; job satisfaction; mental health; physical health

# Resum

Els accidents laborals són un dels problemes més greus per a la salut dels treballadors a tot el món, especialment en el sector de la construcció. En aquest context, analitzem alguns dels factors individuals i organitzatius que les empreses poden manejar per a reduir aquesta sinistralitat. Aquest estudi se centra en el sector de la construcció, un dels quals més afecta a la salut dels treballadors, havent d'enfrontar-se a les conseqüències que d'ells es deriven.
En primer lloc, analitzem la formació en seguretat dels treballadors. Examinem si la formació en seguretat redueix els accidents en el sector de la construcció. Utilitzant dades de les empreses proveïdores de formació, de l'Autoritat Laboral i d'Informa & Bureau van Dijk (SABI), analitzem aquesta relació a partir de les dades de 1283 empreses de construcció durant 11 anys (2007-2017). Els nostres resultats mostren que més hores de formació en seguretat estan associades a més accidents. Els resultats també mostren que només la formació contínua obligatòria impartida per entitats qualificades redueix els accidents, derivant una implicació pràctica per a revisar l'actual formació de seguretat. Aquests accidents laborals afecten directament els recursos humans de l'empresa i a la seva productivitat. Malgrat això, continua existint una escassa cultura de seguretat en les empreses del sector i un coneixement insuficient dels efectes que aquests tenen sobre els resultats de l'empresa. Els estudis anteriors que se centren en la relació entre la sinistralitat i la rendibilitat de l'empresa van trobar evidències mixtes. La nostra hipòtesi és que la sinistralitat perjudica la rendibilitat de l'empresa. I que l'efecte canvia en funció dels nivells de sinistralitat, la rendibilitat de l'empresa augmenta per a nivells baixos d'accidents, mentre que es redueix per a nivells alts d'accidents. Els nostres resultats mostren que la sinistralitat no redueix la rendibilitat de l'empresa. No obstant això , donant suport a les últimes hipòtesis, es confirma una forma d'U invertida, amb una rendibilitat màxima a un determinat nivell de la taxa d'accidents. Hem realitzat les anàlisis utilitzant estimadors d'efectes combinats, aleatoris i fixos per a estudiar la relació entre els accidents i la rendibilitat. A més, hem realitzat els test apropiats per a confirmar la forma que té. Hem utilitzat l'estimació de dades de panell dinàmics per a controlar la endogeneïtat, derivada de que els valors actuals d'algunes de les variables independents estiguin en funció dels resultats passats de l'empresa.
Seguint l'anàlisi dels factors que pot manejar una empresa per a reduir els seus accidents i protegir la salut dels seus treballadors, hem centrat la darrera part de l'estudi en el clima de seguretat. Un dels principals objectius d'aquest treball és proposar un model teòric per a mesurar l'efecte directe i indirecte del clima de seguretat sobre la salut dels treballadors mediat per la satisfacció laboral. Atès que la literatura no ha proporcionat un model generalitzat que pugui reflectir el clima de seguretat, proposem un constructe multidimensional de clima de seguretat, considerant els factors més destacats en la literatura i incloent el capital psicològic com un nou factor que afecta la percepció dels treballadors del clima de seguretat. La satisfacció laboral inclou les condicions de treball, les recompenses i compensacions laborals i la conciliació entre la vida laboral i personal. En aquest estudi, es va utilitzar l'Enquesta Europea de Condicions de Treball (2015), que compta amb dades del sector de la construcció a Espanya. El model proposat es va validar mitjançant l'ús d'un model d'equacions estructurals. Els nostres resultats destaquen que per a millorar la salut mental dels treballadors de la construcció és necessari emfatitzar la importància de la conciliació, les recompenses i compensacions laborals i el clima de seguretat. Quant a la salut física, és crucial controlar tant el clima de seguretat com la conciliació laboral i familiar. Finalment, es presenten algunes recomanacions als directius de les empreses de construcció, donant-los a conèixer els diferents ítems que han de ser controlats per a millorar els seus resultats.

**KEYWORDS:** Formació; constructió; accidents; empresa; rentabilitat; GMM, clima de seguretat; satisfacció laboral; salut mental; salut física

# Resumen

Los accidentes laborales son uno de los problemas más graves para la salud de los trabajadores en todo el mundo. En este contexto se analizan algunos factores individuales y organizativos que las empresas pueden manejar para reducir esta siniestralidad. Este estudio se centra en el sector de la construcción, uno de los más siniestrosos debiendo afrontar los accidentes y sus consecuencias. En primer lugar, nos centramos en la formación en seguridad de los trabajadores. Examinamos si la formación en seguridad reduce los accidentes en el sector de la construcción. Utilizando datos de las empresas proveedoras de formación, de la Autoridad Laboral y de Informa & Bureau van Dijk (SABI), analizamos esta relación a partir de los datos de 1283 empresas de construcción durante 11 años (2007 2017). Nuestros resultados muestran que más horas de formación en seguridad están asociadas a más accidentes. Los resultados también muestran que sólo la formación continua obligatoria impartida por entidades cualificadas reduce los accidentes, lo que indica una implicación práctica para revisar la actual formación de seguridad.

Estos accidentes laborales afectan directamente a los recursos humanos de la empresa y a su productividad. A pesar de ello, sigue existiendo una escasa cultura de seguridad en las empresas del sector y un conocimiento insuficiente de los efectos que estos altos índices de siniestralidad tienen sobre los resultados de la empresa. Los estudios anteriores que se centran en la relación entre la siniestralidad y la rentabilidad de la empresa encontraron evidencias mixtas. Nuestra hipótesis es que la siniestralidad perjudica la rentabilidad de la empresa. Y que el efecto cambia en función de los niveles de siniestralidad, la rentabilidad de la empresa aumenta para niveles bajos de accidentes, mientras que se reduce para niveles altos de accidentes. Nuestros resultados muestran que la siniestralidad no reduce la rentabilidad de la empresa. Sin embargo, se confirma la forma de U invertida, con una rentabilidad máxima a un determinado nivel de la tasa de accidentes. Hemos realizado los análisis utilizando estimadores de efectos combinados, aleatorios y fijos para estudiar la relación entre los accidentes y la rentabilidad. Además, hemos realizado las pruebas para confirmar la forma que tiene. Hemos utilizado la estimación de datos de panel dinámicos para controlar la endogeneidad. Siguiendo el análisis de los diferentes factores que puede manejar una empresa para reducir sus accidentes y proteger la salud de sus trabajadores, la última parte del trabajo se centra en estudiar el clima de seguridad. Proponemos un modelo teórico para medir el efecto del clima de seguridad sobre la salud física y mental de los trabajadores mediado por la satisfacción laboral. Dado que la literatura no ha proporcionado un modelo generalizado que pueda reflejar el clima de seguridad para diferentes industrias y empresas. Proponemos un constructo multidimensional de clima de seguridad, considerando los factores más destacados en la literatura e incluyendo el capital psicológico como un nuevo factor que afecta a la percepción de los trabajadores del clima de seguridad. La satisfacción laboral incluye las condiciones de trabajo, las recompensas y compensaciones laborales y la conciliación entre la vida laboral y personal. En este estudio, se utilizó la Encuesta Europea de Condiciones de Trabajo (2015), que cuenta con datos del sector de la construcción en España. El modelo propuesto se validó mediante el uso de un modelo de ecuaciones estructurales. Nuestros resultados destacaron que para mejorar la salud mental de los trabajadores de la construcción es necesario enfatizar la importancia de la conciliación, las recompensas y compensaciones laborales y el clima de seguridad. En cuanto a la salud física, es crucial controlar tanto el clima de seguridad como el equilibrio entre el trabajo y la vida privada. Finalmente, se presentan algunas recomendaciones a los directivos de las empresas de construcción, dándoles a conocer los diferentes factores que deben ser controlados para mejorar sus resultados.

**KEYWORDS:** Formación; construcción; accidentes; empresa; rentabilidad; GMM, clima de seguridad; satisfacción laboral; salud mental; salud física

# INDEX

# 1. INTRODUCTION

Occupational accidents are a growing problem. According to the International Labour Organization database from 2018, more than 2.78 million people die because of an accident at the workplace or disease every year all around the world (ILO, 2019). This equals over 1,000 deaths every single day from accidents at work and 6,500 from work-related diseases. In 2018, just in the European Union (EU), there were 3,332 fatal accidents and 3.1 million non-fatal accidents that resulted in at least four days of work leave (Eurostat, 2018a). Analyzing these occupational accidents by activity, 20.5 % of all fatal accidents at work in the EU-27 and 11.6% of non-fatal accidents took place within the construction sector (Eurostat, 2018b). Despite advances in construction safety equipment and technology, the construction sector is one of the most dangerous. These accidents have an undeniable human cost to the workers, their families, and society. Besides, they directly affect the company's work performance and organization.

Based on the occupational accidents problem, the Spanish government approved the "Spanish Strategy for Safety and Health at Work "2015—2020". This document set the guidelines to be followed by public administrations to implement policies to improve safety and health conditions at work. They emphasized the need to collaborate with all the intervening agents, especially in higher-risk sectors, such as the construction sector. One of the specific objectives of the last strategy was to improve safety training at all levels, focusing on the quantity and quality of training. To do this, it established several objectives, among which are promoting the design and development of safety training content in collective agreements, using applied information technologies to change the traditional delivering methods, and updating continuous knowledge of all those who should apply the prevention of occupational risks in companies.

This thesis focuses on some organizational and individual factors that can be managed by construction companies to reduce accidents and also this work aims to better understand the effects of these accidents on the companies' economic results. Taking the lines that the government remarked as the aforementioned strategies, in the first chapter of this thesis, we analyze if current workers' safety training decreases firm accidents on-site in the construction sector.

There is a deeply studied relationship between the economic cycle and occupational accidents. Accidents tend to decrease when there is an economic crisis and they increase sharply when the economy recovers. (Fernández-Muñiz et al., 2018; Kossoris, 1938). This fluctuation in the occupational accidents reports is linked to a heavier workload in times of economic expansion, derived from the increase in work and a slower pace of staff hiring (Fernández-Muñiz et al., 2018). It is also necessary to consider the incentives that workers and companies have in reporting an occupational accident. Arocena & Núñez (2005) stated that in times of recession, when unemployment also rises, the workers have less incentive to apply for sick leave, as their future employment may depend on it. Variation of economic speed has also a great impact on increasing (reducing) occupational accidents in the short-term when the economy expands (contracts) (Li et al., 2011). But the recent increase and high accident rate in the construction sector in Spain are not just explained by the activity reactivation after the economic crisis that affected the building sector from 2008 to 2013. Some authors have suggested that there is deficient safety culture in construction companies, especially in Spanish organizations (Alasamri, 2012; Segarra et al., 2017). This lack of safety culture prevents achieving a real improvement in the integration of safety within the managerial processes inside the companies (Fernández-Muñiz et al., 2009). Therefore, it is necessary to implement prevention and safety measures in construction companies in order to avoid accidents, reduce absenteeism, improve co-workers' relationships and safety climate, and ultimately, enhance the economic company's performance. To achieve this, a change in the companies' daily occupational safety and health (OSH) practices is crucial, and a real commitment involving all the staff in OSH tasks is required. Núñez & Prieto (2018) stated that managers have different incentives for leading the OSH investment plans and its management within the company. They claimed that the companies with OSH tasks integrated into their organization and daily activities protect their workers' health and working capacity, which can be essential for the company according to its type of human capital. Consequently, production increases and can lead to an economic benefit for the company. Thus, in the second article of this thesis, we aim at analyzing if occupational accidents have a negative effect on the firm's profitability. Besides, there are just a few studies that focus directly on this relationship. And some of these studies found opposite results. In this work, we want to clear up the discussion raised in three previous studies, carried out by Argilés-Bosch et al. (2014, 2020) and Forteza et al. (2017a), that connect workplace accidents with the firm's economic performance.

Analyzing our previous results, we continuo this study studying the factors that a company can manage to Improve occupational health and safety and protecting the workers' health. This point is one of the main goals of the EU institutions (art.153 of the Treaty on the Functioning of the European Union states). In this line, in June 2021, the EU institutions approved the strategic framework on health and safety at work (2021—2027), highlighting that one of the actual key objectives is the need to improve the prevention of workplace accidents and diseases.
There are many safety approaches used by companies and researchers to determine the safety commitment of a company. Safety culture and safety climate have been deeply studied to help establish internal factors that a company can manage to integrate safety within its processes and tasks and improve its safety outcomes such as workers' safety performance, and health (Casey et al., 2017). Safety culture refers to the value placed on safety in a company during the time, represented by its safety policies, management procedures, and actions (Guldenmund, 2000). Safety climate is defined as workers' perceptions about the importance of safety in their company (Bergheim et al., 2015; Zohar, 2014). It is a snapshot at a particular point in time of some aspects of the company's safety culture. Managers' decisions can improve, first, the safety climate, and if these practices and efforts are constant over time it can lead to a positive safety culture. Safety culture requires multiple methods of assessment over a long period of time, and it requires more time to be modified. Safety climate can be measured formally using survey tools designed to assess an individual's response to key areas of safety, it is strongly influenced by some organizational safety decisions and group social norms (Bergheim et al., 2015). Safety climate is recognized as a key factor for improving safety outcomes such as workers' safety performance and health (Choudhry et al., 2009; Clarke, 2010). Zohar (1980) was the first author to introduce the safety climate concept in the research literature. Most of the literature has demonstrated a relationship between some aspects of the daily task conditions, safety climate, and safety outcomes such as accidents or diseases. Although the literature has evolved since Zohar's seminal work, it is essential to continue researching how safety climate affects safety performance and thereby workers' health, specifically in the construction sector (Choudhry et al., 2009; Han et al., 2021; Luo, 2020).
Therefore, it is important to understand better how to improve the workers' health. We believe that it is necessary to carry out research that provides implications that can help policy-makers and managers to make decisions, and that also provides clear and practical ideas that could be implemented in the tasks carried out by small and medium-sized companies.

# 2. OBJECTIVES

This thesis aims at analyzing the relationship between the safety policies of a firm and its objectives outcomes such as accidents or workers' health and the firm economic results. The main objectives of our research are summarized in the following points:

Specifically, in the first part of this study, this thesis analyzes the current safety training for construction workers in Spain. Our final goal is to examine if the objective of reducing accidents, which was included in the "Spanish Strategy for Safety and Health at Work 2015—2020", approved by the Spanish government, can be met with the current safety training.

To do it, we checked whether it has an effect on the reported accidents. In our analyses, we distinguish if the training is compulsory or voluntary, and the type and length of the courses. We also consider the several training entities that provide training courses for the construction sector in Spain.

Thereafter, we checked if these occupational accidents affect the firm's economic performance, in particular the firm's profitability. Given the scarce number of studies focusing on this relationship, and that the previous evidence was not decisive, another goal of this study is to provide further empirical evidence to know if a link exists between accidents and the profitability of a company. We aim at analyzing with more depth the relationship between the accident rate and the company's profitability in the construction sector, in order to elaborate a clearer business case for OSH investment and make managers consider this a basic step to improve the company's financial and economic performance.

And, finally, this thesis includes an analysis of the firm's preventive organizational and individual factors that concern the safety climate and how it affects the workers' health. We aim to study the relationship between safety climate and construction workers' health by differentiating workers' physical and mental health. In doing so, we propose a model for measuring safety climate using the information and data from a publicly available survey (EWCS). Another purpose of our research is to incorporate in the measurement model the key variable of psychological capital, which has been suggested by some authors (Bamel et al. 2020) but omitted until now in previous models.

# 3. EFFECTIVENESS OF TRAINING IN REDUCING ACCIDENTS IN CONSTRUCTION COMPANIES.

**ABSTRACT**

Workers' safety training in the construction sector needs a change. Accidents in this sector are a growing problem. Only in the Balearic Islands the incidence rate of accidents with sick leave increased from 8,028.5 in 2013 to 10,199.5 in 2016, a 27.04% more. It is the Spanish region with the highest incidence rate almost every year in the last decade. One potential cause of this high incident rate in the construction sector is the quality and quantity of safety training. We examine whether more (compulsory and non-compulsory) safety training reduces accidents in the construction sector. Using data from the training providers companies, the Spanish Labor Authority, and Informa & Bureau van Dijk (SABI), we analyzed this relationship over 1283 construction companies' data over 11 years (2007—2017). Our results show that more hours of safety training are associated with more accidents. Only the continuous compulsory training provided by qualified entities led to a reduction in accidents. These results suggest that one way to reduce accidents in the construction sector is to improve mandatory training.

**KEYWORDS:** Training; construction sector; accidents; prevention

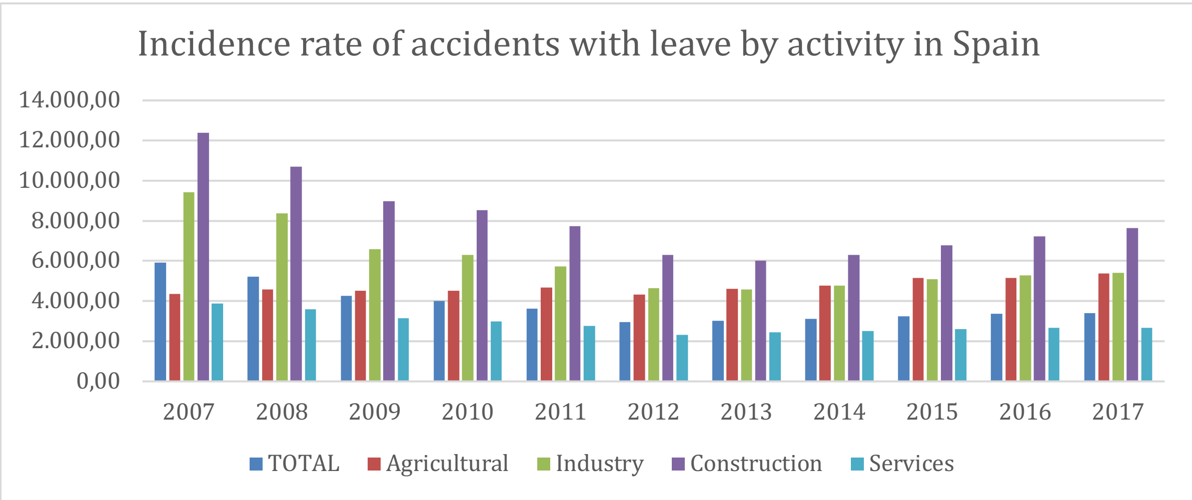
## 3.1. INTRODUCTION

### 3.1.1. Motivation. Background of safety training in the construction sector

Accidents at work are one of the most severe problems for workers' health worldwide. It is due to their high incidence rate [1] and severity, especially in dangerous sectors such as the construction sector.

In the EU countries, the importance of this sector is remarkable. In 2017, in the European Union of 28 (EU-28), there were 3,552 fatal accidents at work, and more than one-fifth of them took place within the construction sector (Eurostat, 2017). Spain ranks 7th country in fatal accidents and 3rd in non-fatal accidents (Eurostat, 2017). Figure 1 shows the incidence rate (IR) of accidents at work with sick leave in Spain by sectors during the period of this study[2] (2007—2017). It can be seen that the IR decreased during the years of the economic crisis, which severely affected the construction sector (2007—2013), but increased from 2013 on. This figure also shows that the construction sector is the one with the highest IR every year.

Fig. 1
The incidence rate of accidents at work with leave by activity in Spain (2007—2017)




Source: Ministry of Labor, Migrations and Social Security, Spanish Government (2018)

In Spain, there were 695 fatal accidents in 2019, 145 of which occurred in the construction sector. Regarding work-related non-fatal accidents, there were 1,359,548, of which 635,227 caused worker sick leave (UGT, 2019). With regards to occupational accidents with sick leave among the group of salaried workers in Spain, there were 71,664 registered accidents in the construction sector in 2019. It represents 10% more than in 2018, the greatest increase of all sectors. As to IRs, the construction sector is the second activity (IR - 8,274.7), just behind the extractive industry (IR- 8,325.2).

Figure 2 shows the maximum, minimum, and mean of the IRs of all the Spanish regions in the construction sector for each year from 2007 to 2017. All regions experienced similar trends during this time, as we saw in the previous figure, the IR decreased from 2007 to 2013, reflecting the economic crisis effect, but it increased from 2013 to 2017. Figure 2 also shows the evolution of the Balearic Islands' IR, which is the region with the highest IR almost every year.

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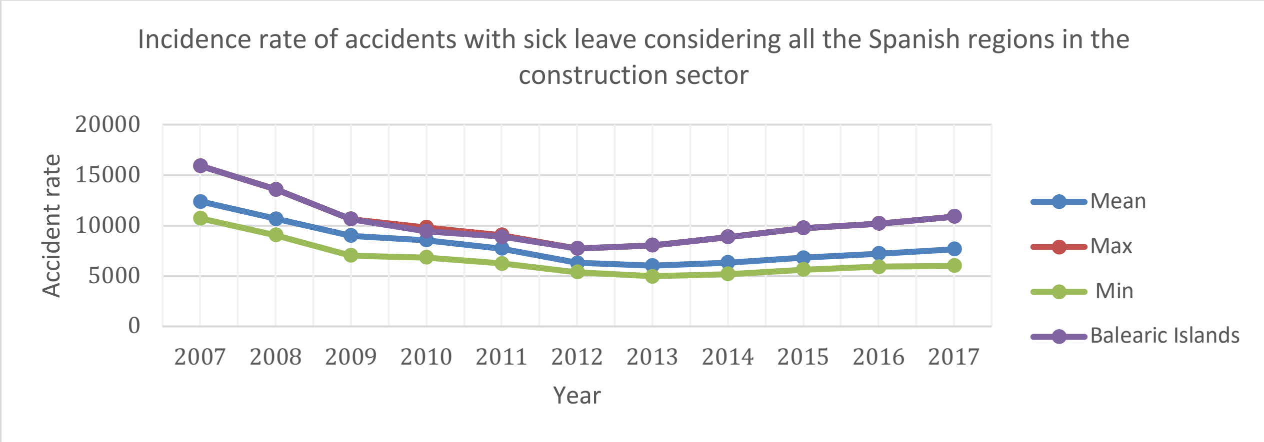
[1] Incidence rate is calculated as the ratio between the number of accidents (non-fatal or fatal for a given year) divided by the number of employed persons multiplied by 100,000.

[2] We have included in this study data until 2017. This is the latest accident data available from the Labor Authority at the time of developing this work.

Fig. 2
IR of accidents with leave in the construction sector in Spain (max, min, mean, and in the Balearic Islands)




Source: Ministry of Labor, Migrations and Social Security, Spanish Government (2018).

Based on the occupational accidents problem, the Spanish government approved the "Spanish Strategy for Safety and Health at Work 2007—2012" and "2015—2020". The Spanish and regional governments and social representatives agreed and signed these strategies. They were developed in biannual action plans. These documents set the guidelines to be followed by public administrations to implement policies to improve safety and health conditions at work. They emphasized the need to collaborate with all the intervening agents, especially in higher-risk sectors, such as the construction sector. One of the specific objectives of the last strategy was to improve safety training at all levels, focusing on the quantity and quality of training. To do this, it established several objectives, among which are promoting the design and development of safety training content in collective agreements, using applied information technologies to change the traditional delivering methods, and updating continuous knowledge of all those who should apply the prevention of occupational risks in companies.

Taking the lines that the government remarked as the aforementioned strategies, the first step we want to study is the effectiveness of training in reducing the companies' accidents.

The aim of this study is to examine if the objective of reducing accidents, which was included in the safety guidelines approved by the Spanish government, can be met with the current safety training.

### 3.1.2. Literature review

There has been much research on accidents at work in the construction sector and other industries. These studies have examined several factors that affect accidents, stressing that accidents are less prevalent when construction sites are less complex and there is a higher level of resources (Forteza, Carretero-Gómez & Sesé, 2016, 2017; Marhavilas & Vrountas, 2018), as well as, the accidents can be reduced when there is a preventive performance on site (Ismail, Doostdar & Harum, 2012; Sousa, Almeida & Dias, 2014). Other studies found that improving the safety climate the reported accidents decrease (Fernández-Muñiz, Montes-Peon & Vazquez-Ordas, 2009). Furthermore, there is some research focusing on the several costs that an accident can entail, how they must be considered, and the negative effect they could have at the company's level (Hasnoot, 1994; Gurcanli & Sevim, 2015; Buica, Antonov, Beiu, Pasculescu & Remus, 2017), among others.

There is also substantial work showing the importance of training, especially safety training, in reducing the accident rate results as well as maximizing workforce performance (Hislop, 1991; Tam, Zeng & Deng, 2004; Ismail et al., 2012; Taylor, 2015; Reiman et al., 2019).

Unfortunately, there are different issues concerning the studies that connect training to objective occupational safety and health (OSH) outcomes. The bulk of them cannot be directly compared because of the large differences in samples and methodologies used. Most of the reviewed studies are theoretical, and the empirical ones are mostly cases of study with a self-selected sample, which limits the generalization of the obtained results and stresses the need of conducting studies with a high-quality randomized sample on the safety training effectiveness (Robson et al., 2010). Furthermore, there is also a need for more longitudinal studies (Cohen & Colligan, 1998; Brahm & Singer, 2013) in order to capture the time effect of this training. All of these issues are due to the lack of a common guideline on those items so as to compare them or a methodology to follow such an analysis. In sum, there is no consensus on the effect that training may have on accidents on site.

*Analyzing safety training programs*

We have reviewed studies investigating, totally or partially, the safety training process, especially in the construction sector. The main points focus on whom it is aimed at, its content, and the type of training. These points suggest that the training can improve safety performance at work and, thereby, reduce measurable outcomes, such as workplace accidents.

Safety training improves workers' knowledge, skills, abilities, and attitudes if the required content and the audience are considered (Kines et al., 2010; Ismail et al., 2012; Dale et al., 2012). But the type of training is crucial; it means the way the training is delivered to the workers. Traditional methods are more common but less engageable than the most innovative methods such as computer aided technologies (CAT, e.g., simulations, virtual reality, computer-generated simulations) (Burke et al., 2006,2011; Brahm & Singer, 2013; Gao, González & Wing, 2019).

*Audience analysis*

Regarding to whom is the training aimed at, we found studies of training programs delivered to stakeholders, contractors (Segarra, Villena, González & Romero, 2017), technicians (Ros et al., 2013; López Arquillos, Rubio Romero & Martínez-Aires, 2015; Hallowell & Hansen, 2016) and workers. Following, we focus the review on workers' training as it is the base of our present study.

The workers' training should differ in several aspects when considering the trainees' individual characteristics. Training that takes into consideration workers' characteristics, such as age, seniority, working sector, or origin, is more specific and effective (Chen & Jin, 2015). Moreover, if the training matches trainees' preferences the transference of OSH knowledge will be more effective (e.g. Nielsen, 2015). Regarding the workers' age, Fung & Tam (2013) stressed that training arrangement needs improvement, specifically for older workers. Concerning workers' seniority, the importance of education is greater if the trainees are new employees, as they need safety orientation to inform them about safety goals (Cheng, Lin, & Leu, 2010; Hallowell et al., 2013; Bavafa et al., 2018). Commonly, in the construction sector, training courses are not adapted to the trainees' level, and they are not provided in the foreign workers' own languages. (Romero et al., 2018). Thus, the training results can be improved by taking into account these characteristics.

A relevant question is whether it should be the company who has to provide the training to the workers or if they have to pay for it by themselves. At this point, it is relevant to differentiate if the workers are self-employed or employees of a company. In this latter case, the size and type of the company are also decisive, as larger ones may be able to allocate more resources to training than smaller ones. The management of workers' training programs is included in the human resources department of medium and large-sized companies. As for small companies, which in Spain represent 99'97% of construction companies, most of them do not have a human resources department, and this task depends directly on the owner or manager of the company.

The companies' human resources management structure affects the company training efforts, especially for the continuous training courses, since they are not compulsory in Spain. For example, in some countries like the USA, the nature and quality of the training provided are very different when union or non-union construction workers are compared. Goldenhar et al. (2001) have confirmed that there is a bigger offer and better structured training for union workers in the USA, so union workers get more advantages from this education. They found empirical evidence showing that training improves behavior and reduces hazard exposures, leading to greater job satisfaction and productivity.

*Content of the safety training*

Regarding the content of the training, it is important to differentiate between compulsory and voluntary. Compulsory training highly depends on each country's public laws and standards (Bernier, 2005). Furthermore, it is also convenient to distinguish between initial and continuous training. The initial training is a requirement to get the first job, while continuous training is the one that workers receive during their working life. Most countries have their own safety and risk prevention regulations in the construction sector, imposing a minimum of training prior to the first job. In Spain, Romero et al. (2018) analyzed the risk prevention training and concluded that 44% of workers had just received a compulsory previous basic course and more than 8% did not receive any training. In the case of supervisors, 38% received just the basic course training, and 27% did not receive safety training.

Following the content analysis, several studies underline the nature of the accidents, identifying their possible causes and analyzing if these weak points are included in the training. They are based on the fact that a lack of safety knowledge results in greater exposure to risk, thus causing a significant number of accidents (Choudhry et al., 2008). Some of these studies found empirical evidence that safety training increases workers' safety knowledge by analyzing the causes of the most common accidents and giving them some tools to reduce the risk exposure (Taylor, 2015; Evanoff et al., 2016; Jeschke et al., 2017). In their study, Dale et al. (2012) evaluate the training contents in ergonomic issues in the construction sector to avoid musculoskeletal injuries and propose new ergonomic solutions to include in the training in order to reduce this injury, which is one of the most recurrent ones.

This effect on the workers' behavior sets the training process as an essential element for OSH management (Choudhry & Fang, 2008; Taylor, 2015; Misiurek & Misiurek, 2017; Reiman et al., 2019). As a first step, the safety training enhances the workers' knowledge and skills about safety at work (Kines et al., 2010; Ismail et al., 2012; Dale et al., 2012), and this increased knowledge improves the attitude of the workers facing the risk, and also the welfare of workers and peer co-worker relationships especially improving workers' communication and consequently the safety climate (Hallowell & Gambatese, 2009; Hale et al., 2010; Zohar, 2010; He, Xu & Fu, 2012; Jeschke et al., 2017; Reiman, 2019).

For these reasons, it is reasonable to state that providing good training can lead to some benefits of a safety organizational climate, since improving the workers' attitude and behavior is easier to better implement safety on site.

There are some other factors, in addition to training, which we know are important to achieve a good safety implementation on site, as well as to reach a good safety climate, including others such as personal awareness to avoid risk exposures and good communication between co-workers (Choudhry et al., 2009; Jeschke et al., 2017; Kim et al., 2021).

Related to personal awareness, the worker's own experience must be considered. Experimental evidence shows that experience has a dramatic effect on the way people judge and make decisions under risk, especially when risks involve low-probability events, such as a work-related accident (Lejarraga & Gonzalez, 2011). Ismail et al. (2012) remarked that personal awareness and good communication are decisive to reaching a good safety implementation on site, as well as forming positive working groups. Moreover, the worker’s well-being improves the stability of the workforce of the companies, creating an environment of trust between colleagues, improving communication for daily work, resolution of labor conflicts, and enhancing productivity (kines et al., 2010).

After having analyzed to whom the training is aimed at and some aspects of its content. The last point that remains to be analyzed is the method of delivering the training to the workers.

*Training methodologies*

The relationship between the effectiveness of the training and the method by which is provided to the workers is questioned by several metanalyses that compare the benefits and limitations of the most traditional methods with the most innovative ones (Burke et al., 2006, 2011; Brahm & Singer, 2013; Gao, González & Wing, 2019). In recent years, more training methods have been implemented in the construction sector -as well as in other industries- that depart from traditional methods based on transmitting just theory by adopting modern approaches with more practices, inclusive e-learning, or virtual reality simulation.

Delivering methods could be classified into two categories. The first one comprises the traditional methods, where we can include courses, seminars, lectures, and talks, based on transmitting just theory or with a little part of practice, where usually a teacher exposes some theory about general or specific OSH topics and the trainees are passive actors with a low level of engagement. The second one refers to the innovative methods like computer-aided technologies (CAT, e.g. virtual reality simulations) where the trainees’ engagement is higher since here the student becomes an active part of the training.

It is not possible to generalize the methods comparison results due to the lack of studies including CAT techniques to evidence training safety effectiveness in improving behavior and injury rate reduction (Gao et al.’s study, 2019). However, there are some studies analyzing several methods comparison, and methods that generate more workers’ engagement seem to have better results in general (Burke et al., 2010; Reiman et al., 2019). However, Robson et al. (2010) questioned Burke et al.’s results because they addressed self-selection in a biased way. Robson et al. (2010) analyzed the engagement hypothesis and concluded that there is a limited number of high-quality randomized trials to test training effectiveness on benefits in knowledge and attitudes, but they found enough high-quality studies verifying training benefits on behavior and health outcomes. Robson et al. (2010) affirmed in their study that it is strong evidence of training effect on worker’s behavior, but for accidents or illness, the evidence was insufficient and not consistent in direction. Brahm & Singer (2013) studied what they called “the engagement theory” and found evidence that training reduces accidents, although there is no method that stands above the rest, traditional or innovative. The training effectiveness depends on the company’s experience and commitment at every moment, increasing the sophistication of delivery methods according to previous levels of OSH commitment of the companies. At the same time, several empirical studies -most of them are case studies with self-selected data-stated that reviewing the safety training content and adding more practices improves the transference of learning, the worker’s behavior on site, which, joined with an improvement in communication between supervisors and workers, reduces the accident rate (Evanoff et al., 2016; Jeschke et al., 2017).

*Training effectiveness evaluation*

Once the training process has been analyzed, the evaluation process would let us know its effect on workers. Some studies show the positive effects of training in reducing the accident rate (Taylor, 2015) and give this training the importance that it needs as it should increase the knowledge of the people involved (Suárez Sánchez, Carvajal Peléz & Catalá Alís, 2017). In this sense, it is not enough to consider if this training really exists, it is also necessary to analyze its effectiveness. To do it, a final control or proof of trainees' knowledge acquisition must be carried out. This grading helps trainees to become more engaged and improves the transfer of knowledge (Blume, Ford, Baldwin & Huang, 2010). Dale et al. (2012) stressed that effective control of the training is required to determine if it is successful. They verified the improvement of final musculoskeletal injuries after designing and implementing a new ergonomic training for construction employees.

Finally, it should be pointed out that it is possible to improve the productivity of the workforce through achieving a good workers' training process, in which we can verify good results in terms of enhancing the knowledge and behavior on site. This is due to the improvement of the safety climate, the labor environment, and the ease to solve labor conflicts between workers. This can retain valuable staff at the company for a longer time and let them gain experience in ergonomic safety and productivity (Alwasel, Abdel-Rahman, Haas & Lee, 2017). Safety training could reduce the accident rate by improving the company safety climate and giving skills to the workers to be able to face interpersonal conflicts at work, which is widely regarded as a job stressor (Chen, McCabe & Hyatt, 2017).

Following the existing training research line to study and reduce occupational accidents on site, the present study aims to analyze if the current safety training in the construction sector in Spain reduces occupational accidents.

Nowadays, the construction sector agreement regulates all the training in Spain. In our study, in order to have more details of the effect that this safety training has on accidents, we distinguish if the training is compulsory or voluntary, and the type and length of the courses.
In doing so, we have built an 11 years panel (2007—2017) with relevant data (accidents, workers level training, company performance, and other control variables) from a representative sample of 1,283 companies in the construction sector in the Balearic Islands, which is the Spanish region with the highest incident rate. The data were provided by the responsible entity for delivering the training in Spain by the construction sector agreement, the Construction Labor Foundation (CLF), which is a non-profit entity formed by the union of the National Construction Confederation (CNC), and the construction and industry unions CCOO and UGT-FICA. In addition, we have data of all accidents that occurred in the region during these years from the Labor Authority (Balearic Islands Government), as we have seen that this is the region with the highest accident rate in the whole of Spain. With all these data, we use panel data regression analysis to study the relationship between the level of training and accidents of a company. Considering the several training entities that provide training courses for the construction sector in Spain. The main one is the CLF itself, with its own facilities and teaching staff. On the other hand, there are entities authorized by the CLF to provide this training, which are the accredited training companies (ATC).

As we said above, the main goal of our study is to find empirical evidence on the relationship between accidents in a company and its safety training policy. To achieve this objective, the following research questions were formulated:

1. Does current safety training in Spain decrease accidents in a company?
2. Does voluntary safety training reduce accidents more than compulsory training?
3. Does the safety training delivering methodology have a direct effect on trained company accident results?

#### 3.1.3. Hypotheses statement

With these premises, we propose the following hypotheses:

**H1. A higher level of workers' safety training can reduce accidents in a company.**
At the end of the study, we will try to verify if there is a direct relationship between the workers' safety training and the accident levels of the companies. Moreover, in the case of finding a direct relationship, we will check if it is negative as we hypothesized.

**H2. A higher level of compulsory safety training can reduce accidents in a company.**
One of the objectives of this study is to clarify the different effects that compulsory and voluntary safety training have on companies' accident results, considering the different levels of training shown in Table 1.

**H3. A higher level of voluntary safety training can reduce accidents in a company.**
Following the H2 and according to some of the statements stressed in the literature review such as the assertion that training has positive effects on objective outcomes, in this study, we will check if a higher level of voluntary training has a positive effect on companies' accident results.

**H4. Companies that received the training at CLF have lower accidents than those that have received the training from an ATC.**
This hypothesis is stated to examine whether exists some differences in accident results regarding the training methodology, since, as detailed in data section (2.1), there are several entities that can offer this training to the workers, and there are differences in the teaching methodology depending on the company that delivers the training.

### 3.2. METHODOLOGY

#### 3.2.1. Safety training courses in Spain

To get started, we describe the safety training in the construction sector in Spain. It is defined in the general construction sector agreement[3] (Table 1).
On the one hand, there is a compulsory training to be able to have access to work for the first time. The compulsory training is made up of two different cycles. The first one is basic risk training, related to general topics delivered in a course of 8 hours length. The second cycle is a specific risk training, related to the job to be carried out on-site, provided in a course of 20-hour length.
Furthermore, there is a higher level of training with a duration of 60 hours that qualifies the worker to carry out preventive resource functions on site. It is common for contractors to have

[3] The general construction agreement establishes the regulatory framework for labor relations in the sector in Spain. Its content refers to the regulation of the general working conditions to be applied throughout its scope and among them, it establishes the mandatory nature of safety training, establishing its different levels, and for each one of them, its minimum content and duration.

at least one worker on-site with this training to be able to develop functions of a preventive resource. It is mandatory on-site to have a preventive resource whenever there may be "serious risks" for the safety and health of workers, according to the Spanish regulation (R.D.1,627/ 97). It also includes a non-exhaustive list of "serious risks" such as falls from heights, burials, jobs near high voltage power lines, exposure to chemical or biological agents, etc. Despite there are several modalities of preventive resources, the most basic, assigning the functions to a worker, is one of the most used.

Table 1
Training classification "VI Construction Sector Agreement"

| Levels of training | | Definition | Length |
|---|---|---|---|
| 1 | First cycle | Initial: Basic and general concepts. | 8 h |
| 2 | Second cycle | Specific training: training by job or by trades | 20 h |
| 3 | Basic level of prevention in construction | Preventive resource on-site training, with general and specific training content to carry out some HS responsibilities. It is the basic level of training for a member of the preventive modality. | 60 h |

Source: Own elaboration based on data from the construction sector agreement

On the other hand, there is continuous training, which is not compulsory. It depends on the will and disposition of the company deciding whether deliver this training to its workers. They can recycle compulsory training by repeating the same courses periodically since there are no specific continuous and refreshing training courses. This fact raises the debate on the efficiency of training over time. Studies are needed to check the safety and Health training effectiveness over time (Burke et al 2006).

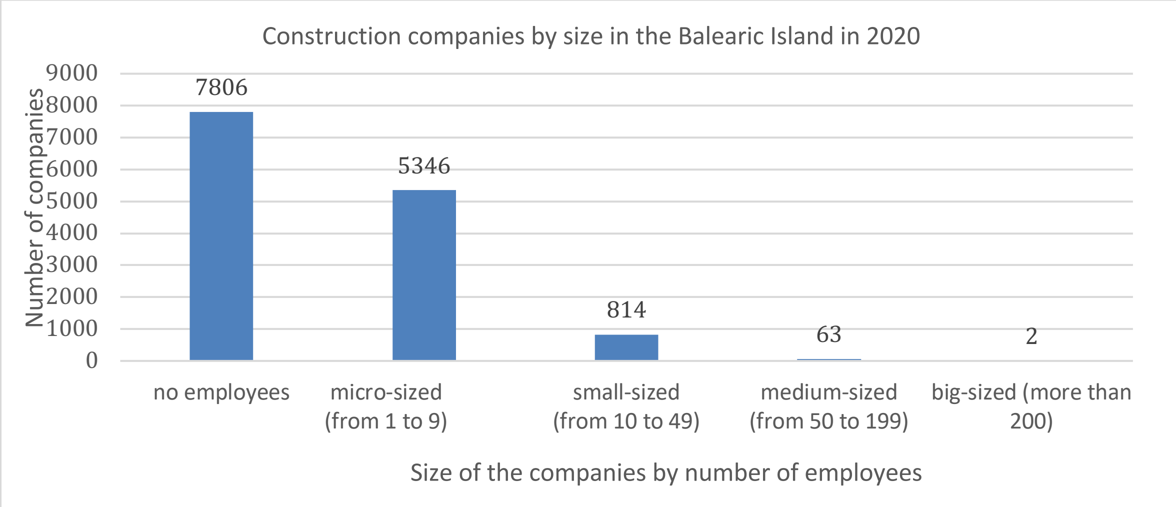
These courses, compulsory and voluntary ones, are all delivered in face-to-face traditional methods. Usually, a teacher gives the information in an expositive lesson, including all the compulsory topics that the agreement establishes for each level. This way, the trainees are mainly passive actors in the training process.

According to the general agreement, the CLF is the entity that has to deliver this education to workers in the construction sector. For years, the training has been delivered as well by some ATCs, which must be accredited by the CLF. These ATCs are usually external prevention services (EPS), that the construction companies can hire if they do not have human resources in their own staff to deliver the training. These EPS companies are specialized in the area of occupational risk prevention and they offer other companies the services to develop the preventive activities required by the law of prevention of labor risks (LPRL 31/1995).

The Spanish regulation offers other options that a company can choose to deliver the safety training, but they are not too representative if compared to the previous option due to the size and configuration of the Spanish construction companies, since they need competent staff to do it.

As figure 3 shows, 99,54% of construction companies in the Balearic Islands have less than fifty employees.
Due to this size, most of these companies opt for an EPS as they do not have qualified personnel on staff to provide the training to their workers.

Fig. 3
Companies' size in the Balearic Islands by number of employees




Source: INE Statistics National Institute from Ministry of Labor, Migrations and Social Security (2020)

Even though the origin and content of the training are the same, as determined by the construction sector agreement, there are some differences in the training regarding the firm that delivers it. CLF has its own facilities where training takes place in classrooms and in practice rooms with real-scale reproductions of construction site scenarios. EPSs usually do not have these facilities and they teach the courses in classrooms with theory and videos to show some real situations, and many times the training is performed at the trained company's facilities.

Regardless of the entity that delivers the training, there is not a formal exam or proof to verify that there has been a transference of knowledge. Instead, all trainees receive a certificate of attendance.

### 3.2.2. Sample

According to the Statistical Institute of Balearic Islands (IBESTAT) in 2017, there were 5,609 construction companies registered in the Balearic Islands.
We start the study with the database of all the companies that figure at SABI (Informa & Bureau van Dijk's database), in order to have the economic information to use in our study. In 2017, in the SABI database were 3,549 companies from the IBESTAT database, which represents 63,27% of the total construction companies.
We crossed the SABI's database (2007—2017) with the training database provided by the CLF and the accidents database provided by the Labor Authority of the same period of time.
Thus, in the final sample, after verifying the existence of all the aforementioned data, remained 1,283 company observations.

We carried out t-tests to check that our sample was not biased due to the use of the data from the companies formed in the CLF but not of the companies formed in ATC, since from these ones we only had the workers' training data. The results do not show notable differences in the average number of accidents with the number of workers, training with missing values, verifying the groups formed in the CLF and those formed in the ATCs.

### 3.2.3. Variables

In our model, the dependent variable is the number of accidents by year that a company has reported. Our independent variables are several training variables. The level of training is

measured as the total hours of training received by the workers of a company per year, the sum of the workers' training of the three previous years, the training variables of the year, and the three previous years but separating the compulsory from the voluntary training. In addition, we created two dummy variables of training to consider who delivered this training if CLF or ATC. We also included some control variables related to aspects of the companies; like size by the number of employees, return on assets, which is a profitability ratio, and capital intensity which is tangible fixed assets divided by the number of employees (Table 2).
Voluntary training, ROA, and capital intensity (K_int) were transformed into natural logarithm to reduce the skewness of our original data.

Table 2
Variables of the study

| | | | |
|---|---|---|---|
| variables | Accident variable | Accidents | Nº total accidents of company by year |
| | Training variables | Total training | Nº total training hours by year |
| | | Total lagged training | Nº total training hours of previous three years |
| | | Total compulsory training | Nº total of first and second cycle training hours by year |
| | | Total compulsory lagged training | Nº total of first and second cycle training hours of previous three years |
| | | Total voluntary training | Nº total of “basic level in prevention” training hours by year |
| | | Total voluntary lagged training | Nº total of “basic level in prevention” training hours of previous three years |
| | | CLF dummy | 1 if the company has training that was delivered by CLF<br>0 if not |
| | | ATC dummy | 1 if the company has training that was delivered by ATC<br>0 if not |
| | Control variables | Size | Number of employees of the company |
| | | Return On Assets (ROA) | Profitability ratio = Net incomes / average total assets |
| | | Capital intensity | Tangible fixed assets/ nº employees |

We collected information by signing several agreements with public and private entities. Those entities are the CLF and the Labor Authority of the Government of the Balearic Islands. Regarding economic variables, we have obtained the information from the SABI database.
The CLF database includes all the data of the training they have provided directly or through any of the ATC. The Labor Authority database includes all the data of the accidents that have occurred in the sector, detailing workers, the company, and its severity. And the SABI database includes all the economic variables for all the years of the study (Table 3).

The training database includes all training delivered to workers in the Balearic Islands from 2007 to 2017, detailing the course type and length and the date when it was carried out. For all the courses delivered directly by the CLF we also have got trainees’ companies, however, we lack this information in most cases for the trainees' firms that received the training directly by any ATC. We have also included information about workers' company in the analysis when they chose an ATC to provide the training to their workers if the trainee has suffered an accident, as we have crossed also accidents database (that includes trainees and company's data) with training database.

Table 3
Data included in the study by levels and sources

| | Training data | | Accidents data | Economic data |
|---|---|---|---|---|
| | CLF | ATC | Authority Labor | SABI |
| company | ✓ | | ✓ | ✓ |
| worker | ✓ | ✓ | ✓ | ✓ |
| economic data | - | - | - | ✓ |

In Table 4, a summary of variables statistics is shown including the number of observations of the variables (N), the mean, the standard deviation, the minimum value (min), and the maximum one (max).

Table 4
Variables statistics

| | **N** | **mean** | sd | **Min** | **Max** |
|---|---|---|---|---|---|
| **Total accidents** | 69,124 | 0.335 | 1.66 | 0 | 99 |
| **Total training** | 5,958 | 27.24 | 74.44 | 0 | 1,884 |
| **Total lagged training** | 1,305 | 123.68 | 229.88 | 0 | 2,866 |
| **Total compulsory training** | 2,446 | 43.06 | 66.07 | 0 | 982 |
| **Total voluntary training** | 2,304 | 25.78 | 77.82 | 0 | 1,260 |
| **Total compulsory lagged training** | 269 | 226.80 | 237.28 | 0 | 1,546 |
| **Total voluntary lagged training** | 234 | 128.03 | 266.62 | 0 | 2,040 |
| **num employees** | 22,887 | 8.83 | 20.27 | 1 | 841 |
| **ROA** | 28,674 | -43.90 | 3,679.20 | -459,645 | 65,536 |
| **Capital intensity** | 21,155 | 33,829.94 | 199,651.5 | -38,040 | 9870589 |
| **RULC** | 26,073 | 3,482.59 | 366,221.5 | 0 | 4.78e+07 |
| **EBITDA per employee** | 22,887 | 98,295.29 | 309,170.1 | 0 | 3.56e+07 |

### 3.2.4. Econometric model

Different options like Poisson and negative binomial regression were suggested considering that total accidents, our response variable, is a non-negative count variable, indicating the number of accidents that a company has reported in a year (Fenn and Ashby, 2004).
The Poisson regression model assumes that the variance and the mean of the dependent variable are equal and this condition is not met in our data, as can be seen in the summary statistics in Table 4. The negative binomial regression model corrects better for data overdispersion, but Allison and Waterman (2002) stated that the negative binomial model with fixed effect produces biases estimates, and after performing the Hausman test ($p<0.05$), the fixed effect model was selected to estimate our model to avoid self-selection problem. We have performed these both count models. To reduce the overdispersion problem in the Poisson model, we have included in our analysis, the Huber—White robust standard errors estimations (Cameron and Trivedi, 2009).

For each hypothesis, we evaluated the model in the linear and quadratic specifications. It is plausible a nonlinear and direct relationship between training and accidents. As we have seen in the literature review, the training improves the worker's knowledge and skills, and this improvement leads to better safety behavior and performance onsite, avoiding risk exposures, and thereby, reducing accidents (Jeschke et al., 2017; Reiman, 2019). The effect of training on knowledge acquisition can be represented by the learning curve method. This method proposes that some objective outcomes, such as individual knowledge and skills, improve over repeated training experiences, rising sharply through their initial accumulation phases and becoming stabilized in later phases (Musaji et al., 2020; Samim et al, 2022). Consequently, the curvilinear relationship between training and knowledge can be reflected also when we link the training with the accident results. Likewise, it should be considered that accidents are due to several causes and that the actual conditions of a construction site are always changing. Workers have to be well-trained to apply their knowledge and skills to different situations, in their daily tasks. In this sense, it is important to consider the benefits of cumulative training with periodic repetition and the effect it can hold over time. To explore this possibility, we have included the quadratic specification in our lagged analyses. In addition, we plotted graphs of the accident-training variables that also suggested a possible linear and quadratic specification considering the training of the same year and also the accumulated training of the previous three years (Fig.4)

Fig. 4
Plot total accidents- total training; Plot Total accidents- total lagged training of the 3 previous years.

**H1. A higher level of worker's safety training can reduce accidents in a company.**

Model 1: Including in the study the training of the year.

- Linear specification

$$\text{Total accidents}_{i,t} = \alpha + \beta_1 \cdot \text{total training}_{i,t} + \beta_2 \cdot \text{nºemployees}_{i,t} + \beta_3 \cdot \text{roa}_{i,t} + \beta_4 \cdot \text{K\_int}_{i,t} + \varepsilon_{i,t}$$

- Quadratic specification

$$\text{Total accidents}_{i,t} = \alpha + \beta_1 \cdot \text{total training}_{i,t} + \beta_2 \,.\, \text{total training}_{i,t}^2 + \beta_3 \cdot \text{nºemployees}_{i,t} + \beta_4 \cdot \text{roa}_{i,t} + \beta_5 \,.\, \text{K\_int}_{i,t} + \varepsilon_{i,t}$$

Model 2: with three years of lagged training

We extend our model to consider the sum of the three years of delayed training to see if the safety training benefits manifest themselves for some time after the training. We chose this period because of the mandatory continuous training required in other agreements in sectors close to construction, such as metallurgy, where the need to renew safety training every three years is established.

- Linear specification

$$\text{Total accidents}_{i,t} = \alpha + \beta_1 \text{ total lagged training}_{i,t} + \beta_2 \cdot \text{nºemployees}_{i,t} + \beta_3 \cdot \text{roa}_{i,t} + \beta_4 \cdot \text{K\_int}_{i,t} + \varepsilon_{i,t}$$

- Quadratic specification

$$\text{Total accidents}_{i,t} = \alpha + \beta_1 \cdot \text{total lagged training}_{i,t} + \beta_2 \,.\, \text{total lagged training}_{i,t}^2 + \beta_3 \cdot \text{nºemployees}_{i,t} + \beta_4 \cdot \text{roa}_{i,t} + \beta_5 \,.\, \text{k\_int}_{i,t} + \varepsilon_{i,t}$$

**H2. A higher level of compulsory safety training can reduce accidents in a company.**

Model 1:

- Linear specification

$$\text{Total accidents}_{i,t} = \alpha + \beta_1 \cdot \text{total compulsory training}_{i,t} + \beta_2 \cdot \text{nºemployees}_{i,t} + \beta_3 \cdot \text{roa}_{i,t} + \beta_4 \cdot \text{K\_int}_{i,t} + \varepsilon_{i,t}$$

- Quadratic specification

$$\text{Total accidents}_{i,t} = \alpha + \beta_1 \cdot \text{total compulsory training}_{i,t} + \beta_2 \cdot \text{total compulsory training}_{i,t}^2 + \beta_3 \cdot \text{nºemployees}_{i,t} + \beta_4 \cdot \text{roa}_{i,t} + \beta_5 \cdot \text{K\_int}_{i,t} + \varepsilon_{i,t}$$

Model 2:

- Linear specification

$$\text{Total accidents}_{i,t} = \alpha + \beta_1 \cdot \text{total compulsory lagged training}_{i,t} + \beta_2 \cdot \text{nºemployees}_{i,t} + \beta_3 \cdot \text{roa}_{i,t} + \beta_4 \cdot \text{K\_int}_{i,t} + \varepsilon_{i,t}$$

- Quadratic specification

$$\text{Total accidents}_{i,t} = \alpha + \beta_1 \cdot \text{total compulsory lagged training}_{i,t} + \beta_2 \cdot \text{total compulsory lagged training}_{i,t}^2 + \beta_3 \cdot \text{nºemployees}_{i,t} + \beta_4 \cdot \text{roa}_{i,t} + \beta_5 \,.\, \text{K\_int}_{i,t} + \varepsilon_{i,t}$$

**H3. A higher level of voluntary safety training can reduce accidents in a company.**

Model 1:

- Linear specification

$$\text{Total accidents}_{i,t} = \alpha + \beta_1 \cdot \text{total voluntary training}_{i,t} + \beta_2 \cdot \text{nºemployees}_{i,t} + \beta_3 \cdot \text{roa}_{i,t} + \beta_4 \cdot \text{K\_int}_{i,t} + \varepsilon_{i,t}$$

- Quadratic specification

$$\text{Total accidents}_{i,t} = \alpha + \beta_1 \cdot \text{total voluntary training}_{i,t} + \beta_2 \cdot \text{total voluntary training}_{i,t}^2 + \beta_3 \cdot \text{nºemployees}_{i,t} + \beta_4 \cdot \text{roa}_{i,t} + \beta_5 \cdot \text{K\_int}_{i,t} + \varepsilon_{i,t}$$

Model 2:

- Linear specification

Total $accidents_{i,t} = \alpha + \beta_1 \cdot$ total voluntary lagged training $_{i,t} + \beta_2 \cdot$ nº$employees_{i,t} + \beta_3 \cdot roa_{i,t} + \beta_4 \cdot K_int_{i,t} + \varepsilon_{i,t}$

- Quadratic specification

Total $accidents_{i,t} = \alpha + \beta_1 \cdot$ total voluntary lagged training $_{i,t} + \beta_2 \cdot$ total voluntary lagged $training_{i,t}^2 + \beta_3 \cdot$ nº$employees_{i,t} + \beta_4 \cdot roa_{i,t} + \beta_5 . K_int_{i,t} + \varepsilon_{i,t}$

**H4. Companies that received the training at CLF have lower accidents than those that have received the training from an ATC.**

Model 1:

Total $accidents_{i,t} = \alpha + \beta_1 \cdot CLF + \beta_2 \cdot ATC + \beta_3 \cdot$ nº$employees_{i,t} + \beta_4 \cdot roa_{i,t} + \beta_5 . K_int_{i,t} + \varepsilon_{i,t}$

Model 2:

Total $accidents_{i,t} = \alpha + \beta_1 \cdot$ lagged CLF $+ \beta_2 \cdot$ lagged ATC $+ \beta_3 \cdot$ nº$employees_{i,t} + \beta_4 \cdot roa_{i,t} + \beta_5 \cdot K_int_{i,t} + \varepsilon_{i,t}$

**Development of the data analysis process**

Once the databases were crossed, we proceeded to create the aforementioned variables in order to make a panel with companies, training, and accidents data[4].

Then we obtain the correlation matrix to see the relationship between our variables in order not to distort the results of the study and avoid multicollinearity. After the regression analysis, the mean variance inflation factor of variables is 1,29, lower than the maximum value tolerable of 10 (Wooldridge, 2009).

Then, we made the negative binomial and Poisson regressions of the observations that complied with the given requirements in linear and quadratic specifications as proposed above. We avoided possible heteroscedasticity bias by using robust errors.

## 3.3. RESULTS

### 3.3.1. Count model results

The analyses performed with Poisson and negative binomial count models reflect similar results, with no notable changes in the significance of the interest variables, providing robustness to the obtained results. As it can be seen in the next tables, where results are shown, the estimations of all models presented significant goodness of fit ($p < 0.01$).

Regarding the first hypothesis, in model 1, where the training of the same year (t) is included, there is a positive and significant relationship between companies' training and accident variables (negative binomial regression (nbreg): 0.0005/ Poisson: 0.0006) in the linear specification (columns 1 and 3 in Table 5). That is to say, the more training of workers by a company, the higher its accident rate. As to the quadratic specification, the linear coefficient of the training variable is positive and significant (nbreg: 0.0005 / Poisson: 0.0010), and the quadratic coefficient is negative but not significant (nbreg: -6.08e-08/ Poisson: -3.30e-07) (columns 2 and 4 in Table 5). Therefore, the results do not provide support for the quadratic relationship between the total workers' training and the accidents reported.
In the extent model (model 2), where the training variable includes the training of the three previous years, the results in the linear specifications show negative and not significant

[4] We use STATA 14.1. to estimate our models

coefficients of the training variable (nbreg: -0.0001 / Poisson: -0.0001) (columns 5 and 7 in Table 5).

As to the quadratic specification of the model 2, the results show positive linear coefficients (nbreg: 0.0001/ Poisson: 0.0003) and negative quadratic coefficients in training variables (nbreg: -1.59e-07 / Poisson -2.50e-07), but just the quadratic training variable is significant in the Poisson regression results (columns 6 and 8 in Table 5), indicating a concave curve decreasing accidents as training increases up to a certain point.

Across models, more training is associated with more accidents. According to the best-fitting model, one hour of training translates to 0.0006 more accidents. Although it is a very small size effect it is contrary to our expectations of a greater effect of safety training in reducing occupational accidents.

Table 5

Regression results. H1. A higher level of worker's safety training can reduce accidents in a company.

| **HYPOTHESIS 1** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Model 1 (Training of the year)** | | | | | **Model 2 (Lagged training)** | | | |
| | **Negative Binomial regression** | | **Poisson regression** | | | **Negative Binomial regression** | | **Poisson regression** | |
| **Variables** | Linear<br>(1) | Quadratic<br>(2) | Linear<br>(3) | Quadratic<br>(4) | **Variables** | Linear<br>(5) | Quadratic<br>(6) | Linear<br>(7) | Quadratic<br>(8) |
| **Total training** | 0.0005***<br>(0.0002) | 0.0005**<br>(0.0002) | 0.0006**<br>(0.0003) | 0.0010*<br>(0.0005) | **Total accum training** | -0.0001<br>(0.0002) | 0.0001<br>(0.0003) | -0.0001<br>(0.0001) | 0.0003<br>(0.0003) |
| **Total training²** | --- | -6.08e-08 | --- | -3.30e-07<br>(2.86e-07) | **Total accum training ²** | --- | -1.59e-07<br>(1.84e-07) | --- | -2.50e-07**<br>(1.26e-07) |
| **Size** | 0.0049***<br>(0.0006) | 0.0057***<br>(0.0005) | 0.0098**<br>(0.0045) | 0.0097**<br>(0.0045) | **Size** | 0.0111***<br>(0.0013) | 0.0112***<br>(0.0013) | 0.0130***<br>(0.0023) | 0.0131***<br>(0.0022) |
| **Return on Assets (ROA)** | 0.0748***<br>(0.0203) | | 0.0416**<br>(0.0195) | 0.0411**<br>(0.0196) | **ROA** | 0.0480<br>(0.0385) | 0.0488<br>(0.0384) | 0.0489<br>(0.043) | 0.0489<br>(0.0427) |
| **Capital intensity (k_int)** | 0.0456**<br>(0.0229) | -0.0172<br>(0.0174) | -0.0125<br>(0.0150) | -0.0130<br>(0.0148) | **K_int** | -0.0095<br>(0.0484) | -0.0108<br>(0.0482) | -0.0457<br>(0.0329) | -0.0461<br>(0.0329) |
| **Goodness of fit:** | | | | | **Goodness of fit:** | | | | |
| **Wald Chi-squared** | 107.28*** | 180.16*** | 1449.90*** | 1623.32*** | **Wald Chi-squared** | 96.99*** | 97.38*** | 379.60*** | 400.28*** |
| **Log likelihood** | -2628,63 | -4.187 | -5.535 | -5.533 | **Log likelihood** | -745,89 | -745,48 | -1589,36 | -1587,98 |
| **No. of observ.** | 2412 | 3858 | 3018 | 3018 | **No. of observ.** | 602 | 602 | 744 | 744 |
| **Nº of groups** | 690 | 1016 | 1283 | 1283 | **Nº of groups** | 181 | 181 | 316 | 316 |

Huber-White robust standard errors are in parentheses.

P < 0.01***

P < 0.05**

P < 0.10*

Regards to our second hypothesis, to disclose the effect that compulsory training has on accidents, the results of model 1 show a negative coefficient in the training variable in negative binomial regression (-0.0001) and positive coefficient in Poisson regression (0.0003), and they are not significant (columns 1 and 3 in Table 6). The results of the quadratic specification show negative linear coefficients (nbreg: -0.0016 / Poisson: -0.0007) and positive quadratic coefficients in both methods (nbreg: 3.71e-06 / Poisson: 2.33e-06), being training variables significant in the negative binomial regression (columns 2 and 4 in Table 6), suggesting a convex curve, increasing the number of accidents for a higher level of training.

As to the results of model 2, in the linear specification, the compulsory training coefficients are positive but not significant (nbreg: 0.0659 / Poisson: 0.0546) (columns 5 and 7 in Table 6). In the quadratic specification, the linear coefficients are positive (nbreg: 1.1517 / Poisson: 1.3694) and the quadratic coefficients of the training variable are negative (nbreg: -0.1132 / Poisson: -0.1360). Becoming significant the linear and quadratic coefficients of the accumulated training variable in Poisson regression (columns 6 and 8 in Table 6).

In all models, more compulsory training is related to more accidents. According to the best-fitting model, the Poisson regression in model 1, one hour of training produces 0.0003 more accidents. In this case, we have also found a very small size effect, and, in the same sense as in our first hypothesis, it is contrary to our expectations of a greater effect of compulsory safety training in reducing occupational accidents.

Table 6

Regression results. H2. A higher level of compulsory training can reduce accidents in a company.

| **HYPOTHESIS 2** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Model 1 (Training of the year)** | | | | | **Model 2 (Lagged training)** | | | |
| | **Negative Binomial regression** | | **Poisson regression** | | | **Negative Binomial regression** | | **Poisson regression** | |
| **Variables** | Linear (1) | Quadratic (2) | Linear (3) | Quadratic (4) | **Variables** | Linear (5) | Quadratic (6) | Linear (7) | Quadratic (8) |
| **Total compulsory training** | -0.0001<br>(0.0004) | -0.0016**<br>(0.0007) | 0.0003<br>(0.0005) | -0.0007<br>(0.0013) | **Total lagged compulsory training** | 0.0659<br>(0.1211) | 1.1517<br>(1.0881) | 0.0546<br>(0.0749) | 1.3694*<br>(0.7513) |
| **Total compulsory training²** | -- | 3.71e-06**<br>(1.44e-06) | -- | 2.33e-06<br>(2.05e-06) | **Total lagged compulsory training ²** | -- | -0.1132<br>(0.1129) | -- | -0.1360*<br>(0.0816) |
| **Size** | 0.0078***<br>(0.0011) | 0.0082***<br>(0.0011) | 0.0127***<br>(0.0042) | 0.0129***<br>(0.0041) | **Size** | 0.0294***<br>(0.0071) | 0.0267***<br>(0.007) | 0.0208**<br>(0.0094) | 0.0189**<br>(0.0092) |
| **Return on Assets (ROA)** | 0.1043***<br>(0.0364) | 0.0960***<br>(0.0362) | 0.054<br>(0.0343) | 0.0525<br>(0.0341) | **ROA** | -0.1068<br>(0.1236) | -0.0935<br>(0.124) | 0.0007<br>(0.0977) | 0.0075<br>(0.0948) |
| **Capital intensity (k_int)** | -0.0180<br>(0.0409) | -0.0142<br>(0.0410) | -0.052**<br>(0.0236) | -0.0508**<br>(0.0233) | **K_int** | -0.0309<br>(0.1336) | -0.0408<br>(0.1344) | -0.0922<br>(0.1199) | -0.091<br>(0.1117) |
| **Goodness of fit:** | | | | | **Goodness of fit:** | | | | |
| **Wald Chi-squared** | 83.97*** | 95.35*** | 574,62*** | 672.09*** | **Wald Chi-squared** | 19.42*** | 20.29*** | 155.50*** | 172.84*** |
| **Log likelihood** | -906.42 | -903.30 | -2415.75 | -2413.63 | **Log likelihood** | -85.94 | -85.40 | -301.85 | -300.19 |
| **No. of observ.** | 789 | 789 | 1213 | 1213 | **No. of observ.** | 74 | 74 | 130 | 130 |
| **Nº of groups** | 256 | 256 | 657 | 657 | **Nº of groups** | 27 | 27 | 78 | 78 |

Huber-White robust standard errors are in parentheses.

P < 0.01***

P < 0.05**

P < 0.10*

According to the results of the effect that voluntary training has on accidents, our third hypothesis, the voluntary training variables are positive and significant in both models in the linear specification (nbreg: 0.0007 / Poisson: 0.0005) (columns 1 and 3 in Table 7) and in the quadratic specification the coefficients of the linear variable are negative (nbreg: -0.1171 / Poisson: -0.0570) and the coefficients of the quadratic voluntary training variables are positive (nbreg: 0.0303 / Poisson: 0.0198). The coefficients of linear and quadratic training variables are significant when we use negative binomial regression in the quadratic specification (columns 2 and 4 in Table 7), showing a convex curve to represent the relationship reflecting a similar positive relationship as obtained in the linear specification.

As to the results of model 2, we have carried out the analysis in the linear specification, because of our data we cannot perform it in the quadratic specification with all the control variables. As can be seen in columns 5 and 6 in Table 7, the voluntary training coefficient is positive but not significant in nbreg, 0.0072, and negative and not significant in Poisson, -0.0546 (columns 5 and 6 in Table 7).

Summarizing the results of the third hypothesis, we have found that the companies that provided more training to their workers have also reported more accidents. Similar to previous results, the found size effect is very small as with an extra hour of safety training, the accidents would be expected to increase by 0.0005. Just as in the previous hypotheses, the expected effect was in an opposite direction to that found.

Table 7
Regressions results. H3. A higher level of voluntary training can reduce accidents in a company.

| **HYPOTHESIS 3** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Model 1 (Training of the year)** | | | | | **Model 2 (Lagged training)** | |
| | **Negative Binomial regression** | | **Poisson regression** | | | **Negative Binomial regression** | **Poisson regression** |
| **Variables** | Linear (1) | Quadratic (2) | Linear (3) | Quadratic (4) | **Variables** | Linear (5) | Linear (6) |
| **Total voluntary training** | 0.0007*** (0.0002) | -0.1171** | 0.0005** (0.0002) | -0.0570 | **Total lagged voluntary training** | 0.0072 (0.0377) | -0.0185 (0.0446) |
| **Total voluntary training$^2$** | -- | 0.0303*** | -- | 0.0198 | **Total lagged voluntary training $^2$** | -- | -- |
| **Size** | 0.0072*** (0.0011) | 0.0069*** | 0.0123*** (0.0043) | 0.0118*** | **Size** | 0.0292*** (0.0072) | 0.0191* (0.0098) |
| **Return on Assets (ROA)** | 0.1061*** (0.0371) | | 0.0488 (0.0355) | | **ROA** | -0.1139 (0.1247) | -0.0142 (0.0904) |
| **Capital intensity (k_int)** | 0.0010 (0.0411) | | -0.0472** (0.0235) | | **K_int** | -0.0366 (0.1356) | -0.0814 (0.1175) |
| **Goodness of fit:** | | | | | **Goodness of fit:** | | |
| **Wald Chi-squared** | 80.85*** | 117.78*** | 617.22*** | 519.09*** | **Wald Chi-squared** | 18.16*** | 167.54*** |
| **Log likelihood** | -849.78 | -1392.62 | -2293.24 | -3537.71 | **Log likelihood** | -82.45 | -286.58 |
| **No. of observ.** | 748 | 748 | 1145 | 1145 | **No. of observ.** | 69 | 118 |
| **Nº of groups** | 247 | 247 | 626 | 626 | **Nº of groups** | 25 | 70 |

Huber-White robust standard errors are in parentheses.
P < 0.01***
P < 0.05**
P < 0.10*

The results of the analyses of our fourth hypothesis suggested that the entity who delivers the training is related to the accident variable. ATC and CLF variables are very significant (p<0.01). In model 1, both linear and quadratic variables have positive and significant coefficients (columns 1 and 2 in Table 8). In model 2, we have obtained a negative and significant coefficient to CLF (-0.2130/-0.2316) and positive but not significant to the ATC variable (0.0103/0.0731) (columns 3 and 4 in Table 8).

Table 8
Regressions results. H4. Companies that received the training at CLF have lower accidents than those that have received the training from an ATC.

| **HYPOTHESIS 4** | | | | | |
|---|---|---|---|---|---|
| | **Model 1 (Training of the year)** | | | **Model 2 (Lagged training)** | |
| | **Negative Binomial regression** | **Poisson regression** | | **Negative Binomial regression** | **Poisson regression** |
| **Variables** | Linear (1) | Linear (2) | **Variables** | Linear (3) | Linear (4) |
| **CLF** | 0.1761*** (0.045) | 0.1866** (0.0738) | **Lagged CLF** | -0.2130*** (0.0431) | -0.2316*** (0.0726) |
| **ATC** | 0.1076*** (0.0.0420) | 0.1107** (0.0466) | **Lagged ATC** | 0.0103 (0.0455) | 0.0731 (0.0652) |
| **Size** | 0.0050*** (0.0006) | 0.0055** (0.0026) | **Size** | 0.0051*** (0.0004) | 0.0072* (0.0037) |
| **ROA** | 0.0387* (0.0211) | 0.0274 (0.0274) | **ROA** | 0.0705*** (0.0155) | 0.0698*** (0.0258) |
| **Capital intensity (k_int)** | 0.0601** (0.0240) | 0.0694* (0.0358) | **K_int** | -0.0635*** (0.0148) | -0.1055*** (0.0331) |
| **Goodness of fit:** | | | **Goodness of fit:** | | |
| **R-squared/Wald chi-squared** | 112.95*** | 66.75*** | **R-squared/Wald chi-squared** | 277.31 | 31.42 |
| **Log likelihood** | -2121.20 | -2131.75 | **Log likelihood** | -7376.64 | -7801.95 |
| **No. of observ.** | 1997 | 1997 | **No. of observ.** | 8048 | 8048 |
| **Nº of groups** | 596 | 596 | **Nº of groups** | 1561 | 1561 |

Huber-White robust standard errors are in parentheses.
P < 0.01***
P < 0.05**
P < 0.10*

Regarding the size company, it can be seen at the results of the regression in all models and specifications that the bigger the company is the more accidents it has, with a positive and significant coefficient.

As profitability variable (ROA) results, in model 1, considering the training of the year, its coefficients are positive and significant in the linear specification in all analyses performed with the negative binomial model (H1: 0.0748 (column 1 in Table 5); H2: 0.1043 (column 1 in Table 6); H3:.0.1061 (column 1 in Table 7) and H4:0.0387 (column 1 in Table 8)). With Poisson regressions, the results are positive but just is significant when the total training of the year is considered, in hypothesis 1 analysis (linear specification: 0.0416 (column 3 in Table 5) and quadratic specification 0.4107 (column 4 in Table 5)). In model 2, considering the lagged training, it is just significant in hypothesis 4 analysis, taking a positive coefficient (nbreg: 0.0705 and Poisson: 0.0698 (columns 3 and 4 in Table 5)).

Concerning capital intensity variable, which is the tangible fixed assets divided by the number of employees of the company, takes a positive and significant coefficient in the regression analysis in hypothesis 1 model 1 and linear specification (0.0456, column 1 in Table 5) when data is performed with negative binomial regression. That is to say, the greater the tangible fixed assets by employee of the company, the more accidents it has. But in quadratic or Poisson regression it loses its significance. In model 1 of the hypothesis 2 analysis, it takes negative and significant coefficients in linear (-0.0521, column 3 in Table 6) and quadratic (-0.0508, column 4 in Table 6) specifications with Poisson regression. In Hypothesis 4 the results are also negative and significant coefficients in both models and both regressions methods (columns 1, 2, 3, and 4 in Table 8).

With these data, the suggested hypothesis that there is a relationship between training variables and accidents is confirmed. There is a positive relationship between the training variables and accidents. We obtain a negative relationship just when we study the compulsory training of the year and accidents, confirming our hypothesis 2 in model 1 in quadratic specification performed with negative binomial regression. At first, this result is in an opposite sense to what we hypothesized as with a higher level of training the companies reported more accidents. A possible reason could be that the companies provide training to their workers after having an accident, changing the direction of the relationship between our variables. To analyze if our results could be affected by an endogeneity problem between training and accidents, in the next section we propose to estimate our models with instrumental variables regressions like other studies have done in order to verify the obtained results (Nuñez & Prieto, 2019).

### 3.3.2. Analyzing the endogeneity problem

The results shown in the previous section are correct assuming that there is a unidirectional relationship between accidents and training. The companies have to provide training to their workers before starting to work. However, this relationship can be in a bidirectional way, considering the possibility that companies carry out part of the training in a reactive way, that is, the one carried out after the accident, either as a measure of the company to try to improve its results or at the request of the labor inspection as a result of the rate of accidents itself.

The method of instrumental variables (IV) provides a general solution to the problem of an endogenous explanatory variable (Wooldridge, 2010). Finding good instruments is a difficult task, especially when in the model there are multiple endogenous variables or when these variables capture different periods or years of study. “A ‘good instrument’ should be relevant and valid: correlated with the endogenous regressors and at the same time orthogonal to errors” (Baum et al., 2003). To use the IV approach with our endogenous variables, we need at least an observable variable, which satisfies these two conditions in order to be a good instrument.

We used some economic variables, listed in Table 9, which represent the financial capacity of the company as instruments to get consistent estimates in our model. The current ratio is an indicator of a company’s liquidity and represents the possibility to invert this cash in the next necessary expenses to the company. The asset turnover ratio can be used as an indicator of efficiency revealing how a company is using its assets to generate revenue. The higher the asset turnover ratio, the more efficient a company is in generating revenue from its assets. The gearing ratio is a measurement of a company's financial leverage, it is one of the most popular methods to evaluate a company's financial fitness. The return On Capital Employed (ROCE) ratio measures the profitability of a company and it is calculated as the company's earnings before interest and taxes (EBIT) divided by capital used. And the Real Unit Labour Cost (RULC) represents the company's competitiveness through its human resources.

It is reasonable to assume that a higher value of these economic variables may increase the possibility of the company hiring training hours for its workers. A better economic situation, captured by these variables, brings to the company the possibility to allocate more efforts to workers' training. Providing to these variables the first condition we mention before. They can be significantly correlated with training variables. As well as they are not related to accidents on site with a direct relationship. If it is a connection between the mentioned economic variables and accidents, it would be a non-direct relationship, it would be through investment in health and safety issues. In addition, is important to note that this H&S investment could have a non-deterministic effectiveness due to, among other things, the non-contingent nature of accidents. Thus, the mentioned economic variables fulfill the two required conditions to be considered as instruments in our models.

Table 9
Instrumented variables

| | |
|---|---|
| Current ratio | The current ratio is an indication of a company's liquidity. It is calculated by dividing the company's current assets by the company's current liabilities. |
| Asset turnover | Efficiency ratio that measures the efficiency of a company's assets to generate revenue or sales. |
| Gearing | Compares some form of owner capital to funds borrowed by the company |
| Return On Capital Employed (ROCE) | Company's earnings before interest and taxes (EBIT) divided by capital used |
| Real Unit Labour Cost (RULC) | Competitiveness through Human Resources |

We performed panel data instrumental variable regression implementing robust standard errors option in our analyses to correct for heteroskedasticity. The RULC, asset turnover, and gearing ratio variables were transformed in natural logarithm to reduce the skewness of our original data. The overidentification and under identification tests results confirmed that our models are well specified and our instruments are valid.

With regards to the first hypothesis, in model 1, where the training of the same year is included, the results of IV regression show that there is a positive and significant relationship between training and accident variables of a company (0.0378, column 1 in Table 10). In model 2, including the training of the three previous years, the results show a positive but not significant coefficient of the training variable (0.0705, column 2 in Table 10).

Summing up, this result confirms that the companies that provide more training to their workers are the ones that reported more accidents. In this case, the size effect is also small but a little greater than without considering IV.

Table 10
Instrumented variables regression results for H1. A higher level of safety training can reduce accident in a company.

| **HYPOTHESIS 1** | | | |
|---|---|---|---|
| | **Model 1 (Training of the year)** | | **Model 2 (Lagged training)** |
| **Variables** | Linear<br>(1) | **Variables** | Linear<br>(2) |
| **Total training** | 0.0378**<br>(0.0155) | **Total accum training** | 0.0705<br>(0.0060) |
| **Size** | 0.0550**<br>(0.0280) | **Size** | 0.1409***<br>(0.0369) |
| **Return on Assets (ROA)** | 0.0720<br>(0.1190) | **ROA** | -0.0948<br>(0.3893) |
| **Capital intensity (k_int)** | 0.1872*<br>(0.113) | **K_int** | 0.4195<br>(0.3990) |
| **Goodness of fit:** | | **Goodness of fit:** | |
| **F (4, 1601)** | 7.19*** | **F (4, 313)** | 4.82*** |
| **Rsquared** | -0.9947 | **Rsquared** | 0.13 |
| **No. of observ.** | 2261 | **No. of observ.** | 461 |
| **Nº of groups** | 656 | **Nº of groups** | 144 |

Huber-White robust standard errors are in parentheses.
P < 0.01***
P < 0.05**
P < 0.10*

Regarding the effect that compulsory training has on accidents when we control for endogeneity by conducting IV regression, our second hypothesis, the results of model 1 showed a positive and significant coefficient (0.0291, column 1 in Table 11), confirming the results of our first analyses. In this case, the size of the effect is slightly greater than the one obtained when we carried out the count model regression without IV. For each extra safety training hour the accidents are expected to increase 0.0291.

Table 11
Instrumented variables regression results for H2. A higher level of compulsory training can reduce accidents in a company.

| **HYPOTHESIS 2** | |
|---|---|
| | **Model 1 (Training of the year)** |
| | **xtivreg** |
| **Variables** | Linear<br>(1) |
| **Total compulsory training** | 0.0291*<br>(0.0161) |
| **Size** | 0.1427***<br>(0.0303) |
| **Return on Assets (ROA)** | 0.0420 |
| | (0.2170) |
| **Capital intensity (k_int)** | 0.2774* |

| | |
|---|---|
| | (0.1634) |
| **Goodness of fit:** | |
| **F (4, 513)** | 9.57*** |
| **Rsquared** | 0.10 |
| **No. of observ.** | 773 |
| **Nº of groups** | 256 |

Huber-White robust standard errors are in parentheses.
P < 0.01***
P < 0.05**
P < 0.10*

We did not find a good IV to conduct the regression analysis in model 2, for H2 and H3. It may be due to our unbalanced panel data and also because we do not have access to workers' company in training data delivered by ATCs, reducing the observations in these models because of the scarcity of the connection of this training to the firm.

There are no large differences between the results of count models and IV analysis regarding hypothesis 1. They reflect similar results with no significant changes in the significance of the variables of interest, confirming the robustness of our results. Meanwhile, the results in hypothesis 2 have changed. In count model analysis in the linear specification, total compulsory training was negative and not significant in nbreg regression and positive and no significant in Poisson regression (columns 1 and 2 in Table 6), and with IV analysis the relationship between compulsory training and accidents is confirmed positive and significant (Table 11).

### 3.4. DISCUSSION

Table 5 shows the results of fitting the models for hypothesis 1, where we state that a higher level of worker's safety training reduces total accidents in a company. We have performed the analyses in two different models. Model 1 includes the workers' training of the same year at company level, using negative binomial regression (nbreg) listed in columns (1), (2), and Poisson regression listed in columns (3), and (4). Model 2 includes the training that workers have received in the three previous years, using the same count regression models, nbreg listed in columns (5), (6), and Poisson listed in columns (7) and (8).
As can be seen in the linear specification in model 1, safety training is associated with reporting more accidents. The IV analysis also confirms this relationship. Therefore, hypothesis 1 results confirm that there is a relationship between training and accidents of a company, but in a different sense than we expected. It can be said that the more the training of workers in the company is, the higher the number of accidents. At first, it is difficult to understand, if we agree that with the training there should be some benefits and great effects on workers' knowledge and behavior, which can improve health and safety performance, reducing the worker's exposure to risk, and consequently could lead to fewer injuries and illnesses.

In the same sense, the results of hypothesis 2 reflect an increase in accidents in the companies that have provided more compulsory training to their workers in the quadratic specification in model 1, which is not met in Poisson regression, but confirmed in IV analysis, when the results are estimated once endogeneity is controlled. Likewise, the results of our third hypothesis also show that when companies provided more voluntary training they reported more accidents in linear specification with both count models, and in the quadratic specification when data was performed with nbreg regression. But we cannot confirm it in IV analysis because of our data.

Thus, all the results obtained from the analyses of our first three hypotheses confirm that more training is related to reporting more accidents.
We believe that part of these results, with a very small effect of more training and greater number of accidents, could be explained by considering the possibility that companies carry out part of the training in a reactive way. This would be when the company provides safety training to its workers once they have suffered an accident. In this way, the company could try to fix the possible errors that caused the accident, by improving the knowledge and behavior of the workers, in order to avoid future accidents. In addition, this reactive training could be provided by the company as a response to a requirement from the labor authority after the accident investigation. Besides, it could also be that the company offers this reactive training to its workers in order to comply with the law, since, as Romero et al. (2018) stated in their study, a large proportion of workers start work without having received the slightest training in prevention.
Moreover, this result is consistent with the statement of Robson et al. (2012), indicated in the literature review, where they stated that there was insufficient evidence to establish the effect of training on health outcomes, such as accidents or illness, and furthermore, the results were not consistent in direction, sometimes obtaining a positive and sometimes a negative relationship.

In the literature review section, we have pointed out some empirical studies that have verified that by changing training programs the objective health outcomes were improved (Evanoff et al., 2016). As well as other studies that obtained a reduction in accident rate by changing part of the training content and delivery methodology (Jeschke et al., 2017). Therefore, this could be one possible intervention to reduce the number of accidents.
It should also be considered that the construction sector has its own characteristics, which can influence this positive relationship as such the workers' awareness, especially older workers, which make their own decisions based on their experience at work rather than based on the prevention training they received. There is a lack of special training for older workers (Fung & Tam, 2013). As Lejarraga and Gonzalez (2011) stated, particularly when the issue includes a very unlikely event, such as an accident, the reliance on experience in a making decision process is greater than reliance on the given information, as such safety training. Thus, when reviewing training to make it more effective, the individual experience of workers should be taken into account (Chen & Jin, 2015).
There is also the possibility of improving training results by changing the delivery methodology (Burke et al., 2008; Jeschke et al., 2017). In all current training, both voluntary and mandatory, courses are mostly conducted using traditional methods. Most of these courses are delivered without real practice, just in a theoretical way. In this method, the trainees just must attend the classes and, in many cases, they have to do it in unsuitable conditions. Some studies related to this issue are identified in the literature review section. Among them, Burke et al. (2008) and Brahm & Singer (2013) studies, highlight the importance of improving trainees' engagement by delivering the courses with more innovative and practical methods, appropriate to the real situation of companies in the sector. Furthermore, it is very important to remark that the compulsory and voluntary training courses in the construction sector in Spain do not have an evaluation to determine if the transference of knowledge is being effective.

Additionally, the internal organization of the companies could affect the accident report. Large companies usually have a more integrated and structured internal prevention system, and often they have their own prevention department within the company. At first, this better organization of safety in the company should lead to better results in risks and accident prevention, as long as their activity is more based on the implementation of real preventive work instead of mere formal prevention compliance. Moreover, it should be borne in mind that this is the department that reports and manages all accidents that occur on their sites, regardless of their severity. In the case of small and medium-sized companies, which do not usually have their own prevention department, this accident communication depends on the seriousness of the accident. If the workers need to go to the mutual insurance company as a result of the accident, it is this latter that communicates the accident to the Social Security system, but if the worker does not need medical attention, it is the owner or manager of the company who has the duty to communicate it. Therefore, it is not certain that all companies do it to the same extent since there are some prevention studies that argue the under-reporting of accidents (EU-OSHA, 2017). In addition, the workers' own criteria for reporting accidents must be considered depending on the size of their company. In a large company, with an integrated prevention management system, it is more likely that all incidents occurring on site will be reported. On the other hand, in a medium or small company, the worker may assume the accident as a normal situation and not report it, especially in cases of accidents without sick leave.

As regards our hypothesis 4, the result of the control dummies of the entity that provides the training, CLF, and ATC showed that the more is the training provided by the CLF and by ATC companies, the more are the accidents. These results changed when the lagged training is considered, which is included in model 2. In these analyses conducted using count models, the results of CLF show a reduction in accidents when the training was provided by the construction labor foundation. Regarding the ATC variable, which represents the training provided by the accredited training companies, it shows an increase of accidents when this training was provided by an ATC. As we explain in the first point of the methodology section (2.1 Procedure and data), the training has the same content regardless of the entity that delivers it, which is specified in the construction agreement. The main difference between the CLF and the ATC is their organizational structure. The CLF is a non-profit entity formed by some labor unions and a group of construction organizations. It has its own facilities with the equipment to include real practices in the training courses, as for example, they train the workers how to assemble, use, and disassemble the equipment and protections that they will use in their daily tasks. In addition, the CLF has specialized teachers to impart the training to the workers. The ATC are private companies that can not give the same services as they do not have the facilities to do it. The ATC usually deliver the training in classrooms or even in the trained company facilities. These more practices in training delivering method can have a better impact on workers' behavior (Jeschke et al., 2017). As with them, workers tend to be more engaged, which makes training more effective (Burke et al., 2010; Reiman et al., 2019). In addition, it is important to consider that we have analyzed in our model 2 the accumulated training to study the training efficiency over time. Some studies argued the need of this kind of studies (Burke et al 2006). In these analyses the training of the last three years was included. As it is established in the construction sector agreement, continuous training is not compulsory in Spain, but the companies can re-train their workers by repeating periodically the preventive courses. In this sense, the only result that links training with fewer accidents is just found when we have considered the accumulated training of the last three years and when it is provided by the CLF. Consequently, it would be essential to include refreshing preventive courses for workers to do them during their working life, and review the methodology to achieve a decrease in the accident rate.

Regarding economic and financial variables analyses, the results suggest that bigger construction companies (by the number of employees), and with higher profitability (ROA), are more prone to have accidents. At first, it could be explained due to larger companies can perform more work at the same time. With more projects, workers are more likely to change their workplace more frequently, as well as change their co-workers more often. In addition, complex jobs tend to be performed by larger companies. These complex and bigger works have their own characteristics that make them riskier since the process involves a higher number of companies -contractors and subcontractors. Furthermore, when their workforce is not enough, they hired temporary and inexperienced workers just for this work, which prevents the company from having stability in the workforce that could reflect the benefits of continuous training and experience.

The variable ROA shows that the greater the efficiency of the company in using its total assets to generate more benefits, the greater the accident it has. Moreover, the estimated positive coefficient of ROA is consistent with Forteza et al. (2017) results, who found that a positive relationship exists between accident rate and ROA for a determined interval of accident rates. Concerning capital intensity variable (Tangible fixed assets divided by the number of employees), our results show that it takes sometimes negative and significant values when we perform the data with count models but when we correct for endogeneity using IV regression, it reflects a positive and significant effect on accidents in model 1. That means the greater the tangible fixed assets the company has by employee, the higher the number of accidents. So, the results show a positive relationship among these variables. That is, the greater the tangible fixed assets the company has by employee, the higher the number of accidents. It can be understood since these tangible fixed assets are physical elements, like equipment, tools, protections, etc. that can affect positively to accidents but it is also true that tangible assets could be more material elements like buildings, etc. losing in this way the effect of these tangible fixed assets.

Summing up, after analyzing all the training, accident, and economic data of the companies, we found that the bigger companies, regarding the number of employees, profitability, and competitiveness through their tangible assets, are more likely to have an accident. As we mentioned above, it can be due to the complexity of work in bigger sites or projects, which are more propensity of having bigger companies, and different typologies of companies working at the same site mixing employed workers with subcontractors' workers and self-employed workers. This kind of work organization could make prevention management more complicated. Regarding the training process, there is not an objective evaluation that allows knowing if there is a transfer of knowledge to the workers, but we have found that the compulsory basic training delivered with traditional methods does not reduce the accident rate. Only the continuous accumulated training provided by the CLF reduces accidents in a company.

## 3.5. CONCLUSIONS

In this study, we have analyzed the relationship between training and accidents in the construction sector. We have built a panel data of eleven years, with accident, training, and economic data of more than 1500 companies. This study provides empirical evidence of the unexpected effect of safety training on accidents in the construction sector in Spain. As we have seen in previous sections, only the compulsory training, prior to the first work access, does not help to reduce the accident rate.

This study provides empirical evidence of the companies that provided more training to their workers reported more accidents. This means that the number of accidents raises as training hours increase. This result could be explained due to most companies have not integrated prevention into their execution processes. They are carrying out more formal than effective compliance with prevention. In order to reduce accident rates, it is necessary to integrate prevention in the company and involve all participants in the process. In this way, the high rates in the sector could be improved, protecting the health of workers, as well as minimizing the personal and economic consequences for workers, companies, and society. One way to address this problem could be the integration of prevention systems in the company, which help to account for all the costs arising from accidents and to manage all the resources available to the company to achieve the goal of reducing them. It will be easier to achieve the goal if companies take the training of their workers seriously as a further step in achieving a better safety climate.

Furthermore, the regulated training is not adapted to the real needs. The content of training and the methods used to deliver it to employees need to be thoroughly reviewed. In terms of content, it would be necessary to review the most salient issues in occupational accidents reported in the sector to include them if there are not already considered. Regarding the teaching methodology, it has to include more practices and make workers more participative in the learning process. This could lead to an improvement in the effect that training has on workers. In addition, it would be advisable to add an objective evaluation at the end of the training, in order to have a minimum certainty of the transference of the training (Blume, Ford, Baldwin & Huang, 2010). Finally, as our results suggested, in order to reduce the number of accidents, it is necessary to promote compulsory continuous safety training, as well as to ensure that this training is provided by entities with enough quality resources to do it. This information will allow studying the actual effect of this training over time. It could be a very good first step to improve the accident results in this sector since all the issues that we have analyzed in the literature review currently are not met.

In sum, based on our results, we believe that a change is necessary in the Spanish regulations to achieve that the training improves its effect on objective outcomes such as accidents. This regulatory change should include a mandatory evaluation or examination in all courses, as well as establishing mandatory continuous training on a regular basis to refresh and reinforce the knowledge acquired by workers, as is already the case in other sectors, such as metallurgy. Our results show that by increasing the accumulated training provided by qualified entities occupational accidents can be reduced. Consequently, there is the possibility to change the direction of the regulated training effect, reducing accidents, and thereby protecting workers.

Limitations and future challenges

Our study presents some limitations being one of the most important that we do not have access to workers’ companies in training data delivered by ATCs. There are many accredited companies and all of them are private companies, with which it is very complicated to sign agreements to obtain data to complete this study. In this study, we present the data of all the companies that have received the training in CLF and some of the ATCs. Of the latter, we have included the companies that we have been able to obtain by crossing the information from the accident databases and the training received in the CLF. It would be interesting if more data of the ATCs could be included in this study.

Considering the high level of accidents in the sector and the cost they represent for workers, companies and the society, it is necessary to develop further studies to confirm the contribution that training can have on workers' behavior and whether, together with other factors, it can influence the company's safety climate to protect workers' health.

One future challenge is to examine the possibility that accidents cause training. For this, a longitudinal analysis could help, or any analysis that could capture the time-varying dynamics of accidents and training.

As stated before is not enough to consider if this training really exists, it is also necessary to analyze its effectiveness. And to do that, it is planned to go to construction sites in order to detect the reality of the companies’ performance to identify the specifics risks and needed skills. During these visits, we want to collect information by delivering a survey of all the workers on site, this will allow us to complement this study with real site data. With all this information we want to analyze in our study if the most important factors are included in the current training and if they are well treated according to the results obtained in the visits to sites. We think it will be interesting due to the non-contingent nature of the relationship between risk and accidents, e.g. not all worker risk exposure situation ends with an accident and not all good preventive workplaces are safe from an accident event.

At the moment we have real data of our visits to sites, we will proceed to review the contents of the current training, including the delivery training method, in order to make it more successful and effective. Aiming to provide workers with the necessary skills to perform their daily tasks and improve their knowledge and behavior so that they can carry out their jobs in a safe and healthy way.

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# 4. WHEN DO ACCIDENTS AFFECT THE COMPANY'S PROFITABILITY?

**ABSTRACT**

Occupational accidents directly affect the human resources of a company and its productivity. The construction sector stands out among the sectors most affected by accident rates. Despite this, there is still a scarce safety culture within the companies in this sector and insufficient knowledge of the effects these high accident rates have on the company results. Previous studies that focus on the relationship between the accident rate and the company's economic performance found mixed evidence. In this paper, we examine this relationship in companies in the construction sector. Our first hypothesis is that accident rates impair the company's economic performance. And the second hypothesis is that the effect changes depending on accident rate levels, the company's profitability increases for low levels of accidents, while it is reduced for high levels of accidents.

Against our first hypotheses, our results show the accident rate does not reduce the company's profitability. However, supporting the latest hypotheses, an inverted U-shape is confirmed, with maximum profitability at a certain level of the accident rate. We conducted the analyses using pooled, random, and fixed-effect estimators to study the relationship between accidents and profitability. In addition, we have conducted the U-test and the Fieller test to confirm the shape it has. We have used dynamic panel data estimation to control for endogeneity, derived from the possibility that the current values of some of the independent variables are a function of past company performance. We provide empirical justification for using GMM estimation of dynamic panel data models to control unobserved heterogeneity. Our study contributes to the literature clarify this complex relationship with an empirical analysis using field data at company level.

**KEYWORDS:** Occupational accidents; construction sector; companies; profitability; GMM estimation

## 4.1. INTRODUCTION

There is an increasing concern about occupational accidents. According to the International Labour Organization database from 2018, more than 2.78 million people die because of an accident at the workplace or disease every year all around the world (ILO, 2019). This equals over 1,000 deaths every single day from accidents at work and 6,500 from work-related diseases. In 2018, just in the European Union (EU), there were 3,332 fatal accidents and 3.1 million non-fatal accidents that resulted in at least four days of work leave (Eurostat, 2018a). Analyzing these occupational accidents by activity, 20.5 % of all fatal accidents at work in the EU-27 and 11.6% of non-fatal accidents took place within the construction sector (Eurostat, 2018b). Despite advances in construction safety equipment and technology, the construction sector is one of the most dangerous.

These accidents have an undeniable human cost to the workers, their families, and society. Besides, they directly affect the company's work performance and organization. These accidents reduce the productivity and erode the company's profitability. For example, in 2018, there were 368.190 working days lost because of occupational accidents in Spain in the industrial and the construction sectors, which represented an increase of 4,13% from the previous year, recovering the accident rate levels of 2010, before the financial crisis affected those sectors (Eurostat, 2018b).

There is a deeply studied relationship between the economic cycle and occupational accidents. Accidents tend to decrease when there is an economic crisis and they increase sharply when the economy recovers. (Fernández-Muñiz et al., 2018; Kossoris, 1938). This fluctuation in the occupational accidents reports is linked to a heavier workload in times of economic expansion, derived from the increase in work and a slower pace of staff hiring (Fernández-Muñiz et al., 2018). It is also necessary to consider the incentives that workers and companies have in reporting an occupational accident. Arocena & Núñez (2005) stated that in times of recession, when unemployment also rises, the workers have less incentive to apply for sick leave, as their future employment may depend on it. Variation of economic speed has also a great impact on increasing (reducing) occupational accidents in the short-term when the economy expands (contracts) (Li et al., 2011). It can be due to the increased hiring of temporary and inexperienced workers when work increases rapidly. These workers tend to increase the reporting frequency of minor occupational accidents (Arocena & Núñez, 2005; Fabiano et al. 2008).
But the recent increase and high accident rate in the construction sector in Spain are not just explained by the activity reactivation after the economic crisis that affected the building sector from 2008 to 2013. Some authors have suggested that there is deficient safety culture in construction companies, especially in Spanish organizations (Alasamri, 2012; Segarra et al., 2017). This lack of safety culture prevents achieving a real improvement in the integration of safety within the managerial processes inside the companies (Fernández-Muñiz et al., 2009). Therefore, it is necessary to implement prevention and safety measures in construction companies in order to avoid accidents, reduce absenteeism, improve co-workers' relationships and safety climate, and ultimately, enhance the economic company's performance. To achieve this, a change in the companies' daily occupational safety and health (OSH) practices is crucial, and a real commitment involving all the staff in OSH tasks is required. This commitment must start from the organization's top management and involve the entire workforce (Fernández-Muñiz et al., 2009; 2017). Núñez & Prieto (2018) stated that managers have different incentives for leading the OSH investment plans and its management within the company. They claimed that the companies with OSH tasks integrated into their organization and daily activities protect their workers' health and working capacity, which can be essential for the company according to its type of human capital. Consequently, production increases and can lead to an economic benefit for the company.

In this study, we want to contribute to the discussion raised in three previous studies, Argilés-Bosch et al. (2014, 2020) and Forteza et al. (2017a), that connect the negative consequences of a poor OSH -through considering workplace accidents- with the company's economic performance.

Regarding the first study, Argilés-Bosch et al. (2014) found that accidents reduce the company's profitability, to a greater extent, the following year's profitability. This empirical study was performed at company's level. These authors worked with a stratified quasi-random sample of 299 companies from three different sectors in Catalonia (99 from the building sector, 100 from retail and household repairs, and 100 from metallurgical except machinery). Their sample covered all the companies that, during a period of six years (1998—2003), reported fatal accidents with available economic information in the Informa & Bureau van Dijk's (SABI) database and the companies that reported minor accidents to reach the number of 100 companies from each sector, with a mean in accident rate[5] variable of 10.7. They posited that the company's profitability decreases when occupational accidents increase. These results were confirmed in two of the analyzed sectors but not in the metallurgical one.

Following this same research question, Forteza et al. (2017a) found that the accidents start to decrease the company's profitability when a high number of accidents is reached. They claimed a non-linear relationship with an inverted U shape, showing that profitability increases for low levels of accident rate and decreases for high levels of the accident rate. This research also was performed at company's level. They analyzed a random sample of 272 construction companies in the Balearic Islands. Their sample included all the companies that reported no accidents and companies with any type of accidents[6], ranging their accident rate variable from 0 to 3, with a mean of 0.13. In their model estimation, the predicted maximum profitability is attained at a relatively high level of the accident rate. Forteza et al. (2017a) found a concave curvilinear relationship between accidents and the company's economic performance. They conducted a limits slope verification to confirm that there was an inverted U shape relationship. Due to the study period (2004-2009), the authors stressed that their results could be likely affected by the start of the global economic crisis that significantly affected the construction sector.

Since Argilés-Bosch et al. (2020) were skeptical about the results found by Forteza et al. (2017a), they revisited the same research question. The authors stated that Forteza et al.'s (2017a) results are unlikely since the accident rate level at which maximum profitability is obtained, is outside the relevant range of this variable. They proposed to carry out the U-test and establish the confidence interval using the Fieller test, following Lind and Mehlum's (2010) study to confirm whether a U-shaped relationship exists. At this point, it should be noted the sample of this study was at the sector level instead of a company level, as it was in the two previous studies. Argilés-Bosch et al. (2020) studied the evolution during 11 years (2008-2018) of the relationship between profitability and accident rate in six different sectors (manufacturing, electricity, water supply, construction, wholesale, retail, and trade and transportation). Since they found similar results as in their first study in 2014, they took this new evidence as an argument for the robustness of their first study's results.

Given all this mixed evidence regarding the effect that accidents have on the company's economic results, as well as the different methodology used to conduct the analyses, the main purpose of this study is to provide further empirical evidence to know if a link exists between

[5] Accident rate is computed as total number of accidents divided by the number of employees
[6] Type of accidents: minor, serious, and fatalities

accidents and profitability of a company. Specifically, we propose to carry out an empirical analysis at company's level with a panel data of 11 years (2007—2017), considering all the different methodologies and tests carried out by the three aforementioned studies and including GMM estimation to control for endogeneity. Furthermore, more studies that focus on the effect of accidents on profitability at company's level are necessary as the results of previous studies are not conclusive (Argilés-Bosch et al., 2020). Beyond the evidence that this study brings to that specific discussion, we believe it also contributes to the scarce number of empirical studies that analyze the relationship between the accidents that a company reported and its economic results (Argilés-Bosch et al., 2014; 2020; Forteza et al., 2017a). Actually, there are very few deep studies focusing on the actual burden of occupational accidents and diseases (Schulte et al., 2017). This lack of studies could be due to the difficulty to account for actual, precise, and complete data of occupational accidents (EU-OSHA, 2017). Especially regarding non-fatal accidents, which, although less costly, are at least 5 to 10 times more common than fatal accidents (Schulte et al., 2017).

The structure of this study is organized as follows: In section 2, we review the related literature and develop our hypotheses. In section 3, we describe the data, our sample, and the methodology of our empirical analysis. In section 4, we present our results providing empirical evidence of the relationship between accidents and the company's profitability. In section 5, we discuss the results and present conclusions.

## 4.2. LITERATURE REVIEW AND HYPOTHESES STATEMENT

There is a lot of literature that focuses on diverse aspects of OSH in order to help prevent accidents. Regarding the economic assessment of OSH, there are studies analyzing the several costs of safety practices, and their benefits to the companies (Cagno et al., 2000; Tompa et al., 2010). For this purpose, there are some studies creating methods to perform the occupational safety economic assessment (Barra et al., 2009a; 2009b; EU-OSHA-2002; Jallon et al., 2011), and some other empirical studies presenting the positive results for the company of the cost-benefits analysis (Fernández-Muñiz et al., 2009; Tompa et al., 2010).

### 4.2.1. The cost of safety

The construction sector has its own characteristics that directly affect a company's economic analysis of its safety costs, such as the type of companies, the projects they carry out, the cyclical activity behavior related to the economic cycles (Fernández-Muñiz et al., 2018), which intensify the increasement of different relationships between participants in the building process (subcontractors, temporary workers, etc.), or the companies' material and technological resources among others. All these characteristics have to be considered to perform a complete safety costs analysis adapted to the company. Regarding the literature focusing on the economic evaluation of the safety costs, they can be sorted into several categories. On the one hand, there are the prevention costs (such as training, committees, safety human and material resources, etc.) and the protection costs (barriers or equipment on-site that minimize the accidents' consequences, like handrails, scaffolds, etc.). On the other hand, there are the costs of accidents and diseases. Many studies focus on these latter costs (Ackay et al., 2018; Buica, Antonov, Beiu, Pasculescu & Remus, 2017; Gurcanli & Sevim, 2015).

<u>The cost of accidents</u>

The total cost of occupational accidents should include all the investment that a company does to prevent occupational accidents to its workers, the expenses of the injury, and the losses these accidents cause. There is a great consensus among researchers (Feng et al., 2015; Takala et al.,

2014) on sorting the costs into direct and indirect ones, as Heinrich did in his seminal article of 1931.
According to Heinrich's theory, still valid, the direct costs are those that can be directly attributed to the accident, and the indirect ones are those that are not easily attributable to a specific item, being therefore difficult to quantify. Some examples of direct costs are wages assigned to victims with sick leave, social and legal costs, uninsured medical expenses, lost working hours by the injured worker and coworkers, material losses, or machines and equipment damages. Some examples of indirect costs are those derived from the investigation of accidents, loss of production due to the time that the site has to remain closed, time of the technicians and foremen spent on the investigation which is deviated from other active tasks of their productive assignments, time of managers' dedication, company's images loss costs, possible lost projects, deterioration of the relationship among workers and among them and the company, the poor performance of workers due to the worsening of the work environment, costs for the loss of the injured worker (experience, knowledge, skills, and abilities), and recruitment, selection, and socialization of a substitute.

Accidents affect the company's work performance as they imply a loss of human capital and material damages. The loss of human resources arises when employees cannot take part in production processes because of on-site accidents. Just in the EU, there were lost 398.430 working days in the construction sector in 2019 (Eurostat's database, 2019), which negatively affects the companies' productivity and, in consequence, their economic performance. The cost of lost workdays due to accidents represents almost 4% of the world's GDP, and in some countries, this rises to 6% or more (ILO, 2019). This high cost of activity loss is one of the immediate consequences that affect the work performance, its organization, and the working teams when an accident occurred. The work site is stopped for the necessary time to deal with the accidents, and the co-workers interrupt their usual work for an undetermined amount of time, which depends on the accident's severity. If there is some machine or tool damage, work cannot be restarted until those will be repaired, affecting the current jobs and the next ones. The organization of work is also affected. Foremen, technicians, and managers have to devote their time and effort to comply with legal requirements instead of using their time to manage, control, and organize the work or to find other new projects. Also, if the company must go through an inspection, which usually happens a short time after the accident, they have to invest human and economic resources and time to correct all the prevention and protection measures, or pay a fine. All these issues can affect the companies' profitability in the short term, which means immediately and during the following year.
Heinrich claimed that the real cost of an accident was approximately 5 times its direct costs. Direct costs are easier to assess than indirect ones. The indirect costs include several hidden costs of the accident which are difficult to quantify, and therefore are not usually considered by companies.

Company's accident economic assessment

Determining the cost of occupational accidents and injuries is difficult. It requires access to not always available data. These are some possible reasons for the low level of integration of this assessment within the construction companies. In addition, managers seem to underestimate the study and analysis of all accident costs, since with these data they could make the appropriate decisions (Schulte et al., 2017). To know the actual cost of accidents, the companies should have a clear accident costs accounting method. But the proposed models have not been widely adopted in the practice (Jallon, 2011; Tappura, 2015). Thus, there is a lack of such a calculating method that includes all the real related costs integrated into the companies' accounting practices (Feng et al., 2015). In this line, many studies focused on proposing methods to perform the economic evaluation of the accidents, trying to help the company in accounting for the indirect costs too. Ibarrondo-Dávila et al. (2015) proposed a management accounting model to estimate direct and indirect H&S costs by identifying the items they have considered in the costs of each group. In addition, they conducted a case study to test their model and concluded that more than 90% of safety costs were not considered in the economic company's analysis. Pellicer et al., 2014, also developed a method to estimate the actual cost of H&S at a construction site (classifying them into four categories: insurance, prevention, accidents costs and recovery of costs). This study shows that the cost of H&S in a construction site is around 5% of the total cost of the project. Hallowell (2011) stated that the final cost of a project can be augmented a 15% if they have experienced accidents during the works, which can represent a big amount at the end of the construction process, thus reducing the profits and economic margin of the companies.

Even though the cost of OSH has been studied, the evaluation of these practices has not reached the companies' practice. So, there is a need to adapt the OSH costs study to the company, and to agree on what needs to be included in the company's economic analyses (López-Alonso et al., 2013; Micheli et al., 2015). These data would contribute to knowing to what extent these costs actually affect the company's economic and financial performance.

Internal and external factors affecting the safety cost assessment

The cost assessment models are not widespread mainly due to the complexity and time requirement of this task. Usually, the managers are overloaded, and if there is not a specific department for health and safety issues, they cannot allocate the required resources to achieve all the data to assess the cost of the accident (Jallon, 2011). It should be noted that there are some external and internal factors affecting the safety economic assessment. There are substantial differences in the actual costs that a company has to face when an accident occurs depending on some specific variables of the company, such as industry, size, structure, and type of work to carry out, among others. Moreover, some external factors, such as government interventions, lead managers not to pay much attention to the real cost of an accident or disease since in most developed countries they must not pay it (Dorman, 2000; Jallon, 2011). An example is the legal injury cost (such as health and medical costs) derived from an accident or sick leave. It varies depending on the country to where the company belongs. The work injured costs are not considered equal in all countries since in most developed countries, the direct costs of occupational injuries and illnesses are covered by private insurance or government injury schemes. In these cases, the company just has to pay a prior fixed annual premium or contribution to public services (Jallon, 2011). Specifically, in Spain, medical costs are paid by an employment injury scheme, the social security system, and by the companies' accident insurance company, which means that construction companies do not have to assume the whole amount by themselves. Hence, the company's actual payment is therefore much lower than the actual cost of the accident (Dorman, 2000; Jallon, 2011).

In any case, although the company does not pay the total cost of an accident or sick leave nor had to face any charged contribution, there are some costs that they have to assume, and these economic burdens do not affect all companies at the same way. It depends on some company's characteristics, such as the size, internal structure, type of human capital, and typology of the projects they carried out. Specifically, in the construction sector, small companies are more affected by accident consequences, whereas in large companies, the economic effect is attenuated due to the higher amount of available resources (Swuste et al., 2012). Arboleda & Abraham (2004) state that smaller companies and those working on small projects or underbudgeted projects tend to have more accidents. Since according to INE (2019), SMEs represent more than 99% of the construction sector in Spain, managers of these companies should be more aware of making a full safety evaluation.

#### 4.2.2. Safety investment benefits

The main benefits of acquiring an adequate safety policy by a company are to prevent occupational accidents and achieve a good safety performance on-site, thereby reducing the related costs and their consequences. There is a lot of literature instructing managers to pay more attention to promoting a real safety culture within the company (Cagno et al., 2011; Choudry et al., 2017), as with this decision, they can improve the OSH organization and results. To achieve it, the commitment of the whole organization in OSH issues is essential (Arocena & Núñez, 2008; Fernández-Muñiz, et al., 2009). The accident rates can be reduced if managers adopt a proactive attitude rather than a reactive one, by including safety approach in the processes that the company has to perform, preparing its workers and giving them the tools to carry it out and responsibilities for their better involvement in the process (Arocena, Núñez & Villanueva, 2008). There are different options to integrate and promote a safety culture within the company such as implementing an OSH management system (Fernández-Muñiz et al., 2014). OSH management systems aim to integrate a proactive approach to the OSH decisions and actions within the company in order to manage and face the work in a healthier way and to comply with legal obligations, reinforcing cycle-control to improve the safety prevention measures in the workplace, and reducing the occupational accidents and illnesses costs and workers' compensation payments (ISO 45001). Arocena & Nuñez (2010) stated that the effort of the OSH management system decreases the company's accident rate. Notwithstanding this statement, most of the construction companies in Spain have not integrated it yet (Fernández-Muñiz et al., 2009; Segarra et al., 2017).

A company that prioritizes the safety culture in the company minimizes some accidents due to work design and organization (Fernández-Múñiz et al., 2012).It should be considered that most of the accidents reported in the construction sector are not due to a single mistake or fault. Usually, they happen because of a chain of mistakes that affect the safety company's performance. If managers consider the OSH tasks in the decision-making process the company's performance improves, and reduce the interruptions in the construction process (Swuste et al., 2012).

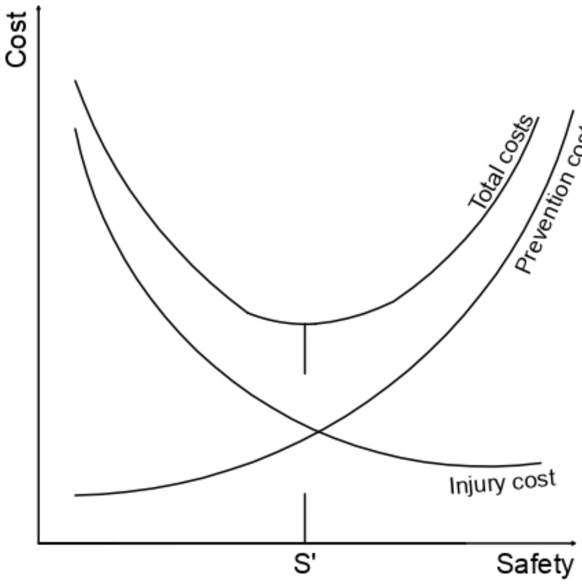
Even though most of the literature demonstrates the advantages of integrating safety within the company, in practice, few companies have developed an actual study to assess the cost of the accidents they have experienced and the return on their safety investment (Cagno et al., 2013). There are some studies focusing on this topic. The European Network for Workplace Health Promotion (ENWHP, 2009) carried out a project where they concluded that for each euro invested in OSH, the company has a return between 2,5-4,8 euros. Thus, managers have objective data on the economic profitability of investing in safety. Although it should be noted that there is a temporary disruption for managers in the decision-making process due to the profitability of preventive actions does not have benefits in the short term (INSHT, 2013). . Consequently, managers need accurate and complete data to study the profitability of the OSH investment.

As far as we know, there are a few studies that have somehow analyzed the relationship between OSH costs and the company's economic performance. Some of them found that safety management increases the companies' financial performance (Fernández-Múñiz et al., 2009), but since most of the companies have not integrated it yet, these results cannot be extended.

#### 4.2.3. Safety cost-benefit analysis

The accidents costs and the benefits of investing in safety are underestimated due to accident costs are not considered to be so high (Gosselin, 2004; Jallon et al., 2011; Shohet et al., 2018). The safety cost model is reflected in Figure 1. It shows the trend over time of the prevention and the injury costs. It also shows the total safety costs curve, which is the sum of prevention and injury costs at each point. This model shows that with an increment in safety investment, the prevention costs increase while the injury costs decrease, which implies there is an optimal equilibrium point when prevention costs meet the injury costs. Therefore, finding the equilibrium point means that a company has to assume a level of risk when managers decide the optimal level of OSH investment under pure economic rationality. Of course, this managerial decision will depend on the own characteristics and interests of the company (Núñez & Prieto, 2018). Notwithstanding, if an optimal investment in H&S issues (prevention and protection costs) exists, it should be the one that minimizes the costs of the accidents without reaching an excess of prevention costs (Forteza et al., 2017a).

Figure 1 Cost of Safety

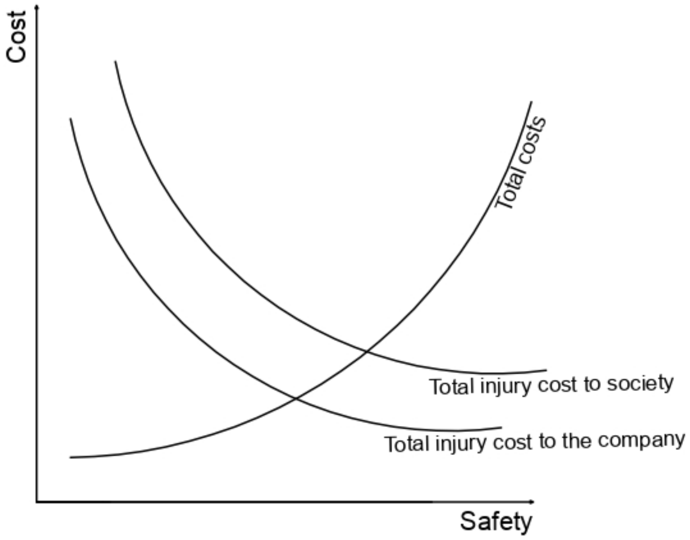



Source: Own elaboration based on: Henderson (1983); Behm et al (2004); Shohet (2018)

The safety cost equilibrium point (S’) does not represent the safety policy objective of the organization, which would be to fully protect its workers’ health. However, in the analysis of the cost of safety, it must be considered that all work has an inherent risk that cannot be easily eliminated. There are risks that will need a high level of resources and cost to be removed, while other risks can be eradicated with little company resources and cost. The purpose of the cost-benefit analysis is to identify the acceptable risk level for the company considering its own characteristics, such as industry, size, structure, available economic resources, country, etc. The organizations have to decide on this level with their own criteria and possibilities. Managers have to design the strategy to follow and the resources they can allocate to safety issues to achieve the risk accepted level, especially when the risk has a significant societal impact (Marhavilas & Koulouriotis, 2021).

In Figure 1, all costs are reflected, the total prevention costs to avoid accidents and the total injury costs when the accident occurred. Prevention costs are usually borne by the company, but, as we have listed above, there are some externalities affecting the injury costs. These externalities impairing the injury cost are government interventions, risk perception differences, moral hazard problems in insurance markets and asymmetric information (Pouliakas & Theodossiu, 2013). A large part of the costs of accidents are not paid directly by the company. Governments, through social security systems, pay for medical services, disability pensions, etc. A company will decide its safety investment to find the equilibrium point (S') between its real costs. Therefore, the effective level of safety that the company sets is reduced by the difference between the total cost of an accident and what the company actually pays, as can be seen in Figure 2.

Figure 2. Inefficiency in the market of OSH.




Source: Own elaboration based on Pouliakas & Theodossiou, 2013, graph author: Henderson (1983, p.80)

Figure 2 shows the inefficiency in the market of safety (Pouliakas & Theodossiu, 2013, explaining the Henderson (1983 p.80) model). It shows that the optimal point between total prevention costs and total injury costs is not static. The decrease of the optimal safety company’s level depends on the difference in its assessment of their possible injury costs. The company's incentives to invest in safety must compensate for the expected costs of having accidents and their consequences, as described above. These incentives are affected when the company does not have to face the real cost of accidents suffered by its workers due to externalities (Pouliakas & Theodossiu, 2013). Furthermore, the characteristics of the firm can also affect the company’s willingness to invest in OSH, since the cost of replacing the human capital will lead the company to take more care of this issue and elevate the level of its safety investment if the workers are experienced and training workers, or if they have some specific characteristics that made them more difficult to replace. In these cases, the cost of finding substitutes will be more difficult and costly. In this sense, the competitive company’s safety investment level is usually suboptimal. (Núñez & Prieto, 2018; Pouliakas & Theodossiu, 2013).

### 4.2.4. Hypotheses statement

Up to this point, we have seen the company’s performance could be affected by accidents directly and indirectly. Companies’ performance affects their productivity and profitability. Companies must find their optimum point of safety investment that maximizes their profitability reducing accidents consequences. Therefore, in order to check whether occupational accidents affect the company’s economic performance, we test the main hypotheses that Argilés et al. (2014, 2020) and Forteza et al. (2017a) stated in their studies. We consider the accidents and the economic results in the same period of time to capture the short-term effect. Then, our first hypothesis is stated as follows:

**H1a. Occupational accidents are associated with a lower company’s financial performance in the same year.**

Furthermore, some accidents consequences for the company can appear in the following months, thus, affecting the firm in the medium-term. Argilés-Bosch et al. (2014) stated that the negative relationship between accidents and profitability is stronger when the profitability of the following year is considered. Jallon et al. (2011) declared that occupational accidents have a very significant impact on company productivity in the short term as well as in the medium term. The time that the heads of the company -from managers, technicians to foremen- have spent dealing with the accident consequences, they cannot spend it organizing the jobs, which could affect the good management of the company's resources and works, thus, affecting productivity. If the people in charge have to be involved in a trial, it would be a long process, where the company has to devote time and resources to prepare and face it. Also, an accident can produce a worsening of the work environment between co-workers, which can affect the jobs to be done. The company's new works can also be affected by an accident because it can produce a company's image loss and make some possible clients not hire the company. All these items can affect productivity, although they are difficult to account for, and their effect on profitability -through lower productivity- could be seen in the medium-term. So, to follow the analysis of how profitability can be affected by accidents, it could also occur during the year after the accident. Therefore, to test the second hypothesis of Argilés-Bosch et al. (2014;2020), we adapt our first hypothesis to check this time effect:

**H1b. Occupational accidents are associated with a lower company's financial performance in the following year.**

The following discussion focuses on the constancy of this effect through the different levels of accidents. As we mentioned above, to estimate the real cost of safety, a company has to account for the prevention and protection costs, as well as the costs of the accidents. There is a direct relationship between profitability and costs, as profitability is calculated considering total revenues minus total costs. There is not a direct relationship between safety performance, risk exposure, and, consequently, accidents, that is to say, all the exposures to risk do not end up in an accident (Forteza et al., 2017a). Also, a company that has a poor safety investment and safety performance can report zero accidents, although its workers are exposed to risk. In this case, with a very low cost in OSH the company can report zero accidents, and it can have better economic results. However, if one of its workers has an accident, which is likely because of the uncontrolled hazards and high-risk exposures, then, the company could finally pay even more than what would have invested in preventing and protecting its workers. In this sense, and following the safety cost model showed in figure 1, the relationship between the safety investment in a company and its accidents is likely to be no-linear but curvilinear. Therefore, it is reasonable to test if there is a non-linear relationship between accidents and the company's profitability, where the latter varies positively with accident rates and negatively with the square of accident rates. Forteza et al. (2017a) found this curvilinear relationship adopting an inverted U-shape between accidents and a company's profitability while Argilés-Bosch et al. (2020) declared weak evidence of this curvilinear relationship and the few cases they found support to this hypothesis it adopted a U-shape instead of an inverted U-shape.

Due to the nature of our variables, the relationship between profitability and costs, and that the previous evidence is not decisive, we state the second hypothesis in the search for more evidence and conclusive results.

**H2a. Low levels of occupational accidents are associated with an increasing company's profitability while large levels of accidents are associated with a decreasing company's profitability.**

The last hypothesis we want to test, similarly to what we have proposed in the two first hypotheses (H1a & H1b), is aimed to check for the existence of a delayed effect of safety policy on the economic company's performance when a quadratic model is considered. The idea is to test whether current accidents' effect will be reflected in one-year ahead economic results, in other words, whether the relationship has a medium term nature. Therefore, our fourth hypothesis states as follows:

**H2b. Low levels of occupational accidents are associated with an increasing company's profitability in the following year while large levels of accidents are associated with a decreasing company's profitability in the following year.**

In this paper, we aim at analyzing with more depth the relationship between the accident rate and the company's economic performance in the construction sector, in order to elaborate a clearer business case for OSH investment and make managers consider this a basic step to improve the company's financial and economic performance.

## 4.3. METHODOLOGY, SAMPLE, AND DATA.

### 4.3.1. Empirical design

To start the analysis, we replicate the models that Argilés-Bosch et al. (2014;2020) and Forteza et al. (2017a) used to estimate the effect of accidents on the company's profitability. Following, we present the four different models we have used to check our aforementioned hypotheses. These models connect accident rates with the company's economic performance. The first and the second model are linear specifications while the third and the fourth ones are quadratic specifications, in order to find a possible curvilinear relationship.

(Model 1)

H1a: $ROA_{i,t} = \beta_0 + \beta_1 \cdot ROA_{i,t-1} + \beta_2 \cdot ACCRATE_{i,t} + \beta_3 \cdot CHASSETURN_{i,t} + \varepsilon_{i,t}$

(Model 2)

H1b: $ROA_{i,t} = \beta_0 + \beta_1 \cdot ROA_{i,t-1} + \beta_2 \cdot ACCRATE_{i,t-1} + \beta_3 \cdot CHASSETURN_{i,t} + \varepsilon_{i,t}$

(Model 3)

H2a: $ROA_{i,t} = \beta_0 + \beta_1 \cdot ROA_{i,t-1} + \beta_2 \cdot ACCRATE_{i,t} + \beta_3 \cdot (ACCRATE_{i,t})^2 + \beta 4 \cdot CHASSETURN_{i,t} + \varepsilon_{i,t}$

(Model 4)

H2b: $ROA_{i,t} = \beta_0 + \beta_1 \cdot ROA_{i,t-1} + \beta_2 \cdot ACCRATE_{i,t} + \beta_3 \cdot (ACCRATE_{i,t-1})^2 + \beta 4 \cdot CHASSETURN_{i,t} + \varepsilon_{i,t}$

In our four models, the dependent variable is return on assets (ROA), which is a standard ratio of company profitability. ROA is defined as the operating income before depreciation divided by fiscal year-end total assets, and it is commonly used in the literature as a proxy for company's financial performance (Wintoki, 2012). In our models and regarding the replicated studies, we have included the lagged ROA variable, as Argilés et al. (2014, p.125) stated with this variable "captures an array of company and management characteristics that have to be taken into consideration when explaining future company performance". Thus, they assumed that current profitability can be partially explained by past profitability. However, Wintoki et al. (2012) stressed that endogeneity can arise when past variables of the dependent one are included in the model and they are not well treated in the estimation. They argued that there is an inference that could lead to biased and inconsistent parameter estimates. Also, they stated that the appropriate empirical model should be a "dynamic" model, including the past variable of the dependent one. They consider that the appropriate estimation of this kind of model is using the dynamic GMM panel estimator to account for unobservable heterogeneity. For comparison reasons, we replicate the models' estimation as in Argilés-Bosch et al. (2014; 2020) and Forteza et al. (2017a), but also, we correct the estimation method using a dynamic GMM panel estimator to control for unobservable heterogeneity.

The independent variable of interest in our study is the total number of yearly accidents that a company has reported, which is identified first in the linear model specification (H1a and H1b), and then we have included the squared term of accident rate variable in the quadratic specification (H2a and H2b).

Following the studies of Argilés-Bosch et al. (2014;2020) and Forteza et al. (2017a), we include the change in assets turnover (CHASSETURN) to consider an efficiency control variable in the model. This variable can be interpreted as the company efficiency change introduced by the management in the current year (Argilés-Bosch et al., 2020). It is defined as the difference between asset turnover in a given year and the previous one. We expect a positive relationship between this variable and ROA, as managerial decisions can improve the company's efficiency and lead to an increase in the company's profitability.

ROA and Assets turnover are variables affected by external influences, but in this study, we want to focus on the relationship between accidents and a company's performance. Thus, these other factors are beyond the scope of this study.

### 4.3.2. Sample and Data

According to the Statistical Institute of Balearic Islands (IBESTAT) from 2007 to 2017, there were an annual average of 5,043 construction companies registered in the Balearic Islands. We started the construction of our dataset with the companies that have their economic data in the SABI's database in the Balearic Islands between 2007 to 2017. There were 2,579 active companies per year on average.

Table 1
Companies with ROA data in the SABI's database. Micro (nº of workers ≦ 10); Small (nº of workers from 11 to 50);

| year | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total number of companies | 2701 | 3039 | 3005 | 2678 | 2527 | 2412 | 2253 | 2302 | 2514 | 2616 | 2324 |
| Company's size by number of workers | | | | | | | | | | | |
| Micro | 1566 | 1839 | 1917 | 1735 | 1656 | 1549 | 1448 | 1458 | 1532 | 1573 | 1414 |
| Small | 702 | 632 | 496 | 420 | 339 | 290 | 275 | 288 | 340 | 405 | 436 |
| Medium | 69 | 51 | 40 | 32 | 28 | 19 | 16 | 21 | 29 | 26 | 33 |
| Large | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 |
| Without size data | 363 | 515 | 551 | 490 | 503 | 553 | 512 | 533 | 612 | 610 | 440 |

Company's size: Micro (nº of workers ≦ 10); Small (nº of workers from 11 to 50); Medium (nº of workers from 51 to 250); Large nº of workers > 250.
Source: SABI's database

Table 1 shows the company's observations for every year of the study. For example, in 2007 (second column of Table 1) there were 2,701 construction companies in the SABI's database with ROA data, 1,566 of which were micro-sized, 702 were small-sized, 69 were medium-sized and 1 company was large sized. Also, there were 363 companies with ROA data but without the number of employees' data this year.

Looking at the data in table 1, we can see that our panel data is unbalanced. The same companies are not maintained throughout the period of study in the SABI's database. It is easily explained as some companies have disappeared during the period, new ones were created, and/or simply because some companies did not report their data every single year and so be excluded from the SABI's database. The previous studies at company's level (Argilés-Bosch et al., 2014; Forteza et al., 2017a), that we intend to replicate, met the same condition in their samples. The results of an unbalanced panel estimated with linear models are valid (Wooldridge, 2010, p.828—832).

The Labor Authority of the Government from the Balearic Islands regularly elaborate a database that collects all the data regarding all the accidents reported in the construction sector, detailing the worker, the company, the accident severity, etc. Table 2 shows the data of accidents and the companies that reported at least one accident, for the period considered in this study. For example, in 2007, there were 4.981 occupational accidents reported by 1,425 construction companies in the Balearic Islands.

Table 2
Information on the yearly accidents in our sample.

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of companies with acc>0 | 1,425 | 1,285 | 950 | 783 | 677 | 526 | 511 | 536 | 647 | 704 | 779 |
| Number of accidents | 4,981 | 3,796 | 2,295 | 1,780 | 1,429 | 1,060 | 1,028 | 1,198 | 1,630 | 1,791 | 2,187 |

Source: Labor Authority. Government from the Balearic Islands.

Then, we merged the SABI's database with the accidents database for the panel 2007-2017 to have the final dataset for conducting our analyses. Thus, in the final sample, after verifying the existence of all the data, 18.451 observations from 3.781 companies remained. The sample error of our final sample was less than 1.19% with 95% of statistical confidence (Del Castillo, 2008).

In summary, our final sample is composed of all the construction companies with information in the SABI's database, including all the companies that have reported accidents[7] during the period of study and the companies that had no accidents.

### 4.3.3. Variables

In our model, the dependent variable is the return on assets (ROA), which is a profitability ratio representing the company financial performance (Argilés-Bosch, 2014;2020; Forteza et al., 2017a; Wintoki et al., 2012). Our independent variable is the number of total accidents by year that a company has reported divided by the number of employees (accident rate). This variable ranges from 0 to 5, with a mean of 0.070. This low average is reasonable because our sample includes all the companies that have reported any accidents but also all the companies with no accidents. Furthermore, as we have mentioned in chapter 3.1, we have included some control variables related to company-specific aspects such as the change in assets turnover (chasseturn) to control for the company's efficiency and lagged ROA (see Table 2).

In table 3, a summary statistic of the variables in our panel is shown, including the total number of observations of the variables (N), the mean, the standard deviation (s.d.), the minimum value (Min), and the maximum one (Max). Regarding the company's size, we have 22,887 observations in our panel data, and the mean of the number of employees per company is 8.835, due to the major part of micro-sized companies (less than 10 workers).

Table 3
Variable's descriptive statistics.

| | **N** | **Mean** | **s.d.** | **Min** | **Max** |
|---|---|---|---|---|---|
| **ROA** | 28371 | -1.132 | 25.793 | -199 | 199 |
| **Total accidents** | 69124 | 0.335 | 1.663 | 0 | 99 |
| **Number of workers** | 22887 | 8.835 | 20.266 | 1 | 841 |

[1]Minor, major and fatal accidents reported by construction companies are included in our sample.

| | | | | | |
|---|---|---|---|---|---|
| **Accident rate** | 22689 | 0.070 | 0.164 | 0 | 5 |
| **Accident rate²** | 22689 | 0.032 | 0.323 | 0 | 25 |
| **Chasseturn** | 22665 | -0.363 | 464.595 | -28855 | 28547 |
| **Lagged ROA** | 22665 | -25.129 | 3064.461 | -459645 | 3715 |
| **Lagged Accident rate** | 18691 | 0.069 | 0.163 | 0 | 5 |

Table 4
Pearson correlations between variables of the study.

| Variables | ROA | Accident rate | Accident rate² | Change in asset turnover | Lagged ROA | Lagged accident rate |
|---|---|---|---|---|---|---|
| ROA | 1.000 | | | | | |
| Accident rate | | 1.000 | | | | |
| Accident rate² | | 0.680** | 1.000 | | | |
| Changeasseturn | | | | 1.000 | | |
| Lagged ROA | | 0.015** | | | 1.000 | |
| Lagged accident rate | | 0.161*** | 0.041*** | | | 1.000 |

Significance level:
P < 0.01***
P < 0.05**
P < 0.10*

In table 4, the Pearson correlation matrix for the variables of the model is reported. There were low correlations between the variables in our study. Even so, a low but significant and positive correlation between the accident rate variable and past performance (lagged ROA) is detected (0.015 p<0.05), as well as the correlation between accident rate with lagged accident rate (0.161 p<0.01), suggesting a possible problem of collinearity between these variables. After conducting a test for collinearity by using the variance inflation factor (VIF), the mean variance inflation factor of variables is 1.55, lower than the maximum value tolerable of 10 (Wooldridge, 2009). So, we rejected that collinearity is a problem in our model.

## 4.4. RESULTS

Regarding the nature of our data, we have performed panel data estimations. In all our analyses we have included the Huber-White robust standard errors estimations to control the possible existence of heteroscedasticity. After conducted the Hausman test, the null hypothesis was rejected (p<0.05), then, a fixed effect model is the one that seems to be more efficient and consistent in our panel data. However, considering the nature of our data, with all construction companies that do not have distinctive individual characteristics correlated with our independent variables, we consider convenient to estimate our model with random effects. Therefore, to test our hypotheses[8], we have considered pooled, random and fixed effect estimators, and we have also conducted the GMM dynamic fixed-effects model to check if there is an endogeneity problem in our data.

Table 5 shows the results of our hypothesis 1a, testing the relationship between accidents and the company's profitability in the same year in the construction sector. In columns 1, 2, and 3 the baseline model results are presented. In columns 4, 5, and 6 the full model is presented,

[8] We used STATA 14.1. to estimate our models.

incorporating the independent variable of interest (accident rate). In columns 7, 8, and 9, the result of the estimated model is shown including the year dummies variables. Finally, in column 10, the GMM dynamic fixed-effects model results are shown.
Fixed effect estimators are shown in columns 3, 6, and 9 of Table 5, and random estimators are shown in columns 2, 5 and 8 of Table 5. In addition and following Wintoki et al.'s (2012) argument of there is a possible endogeneity problem when the past value of the performance variable is used in a model of current performance, we have also carried out the analyses with a dynamic fixed-effects model using the GMM method. This has been presented as the appropriate methodology if there is a dynamic relation between past values of the explanatory variable and current realizations of the dependent variable, and to avoid bias that can derive from a fixed-effects regression (Wintoki, 2012). As far as we know, this methodology has not been used in OSH literature, but it is quite standard in some fields such as Economics, where researchers of financial studies usually have to deal with serious issues because of endogeneity (Roberts and Whited, 2013; Wintoki et al., 2012). This estimator was explained by Arellano and Bond (1991), among other authors, and further developed by Arellano and Bover (1995), and Blundell and Bond (1998). It consists in using lags of dependent and independent variables for identification. Although the theoretical model we have presented above is not explicitly dynamic, we think it is necessary to check this possibility, as there could be a dynamic relation between the determinants of accidents and past economic company's performance, which may introduce endogeneity into an estimation of company performance with accidents. This is because negative past performance affects the resources that a company has and therefore those can be allocated to OSH issues. Also, managers' decisions are limited as the company's profitability decreases. The lack of the appropriate resources and the organizational complexity can affect the work performance on site, and finally, the number and the severity of the accidents can increase (Forteza et al., 2017b).

We carried out two tests to control the suitability of GMM method. To check that there is no serial correlation in the error term -an essential condition to allow to use lagged levels and lagged differences as instruments-, Arellano and Bond (1991) suggest these two tests to confirm this exogeneity assumption. One of the tests is for checking that there is no autocorrelation in second differences, and therefore, this test (AR(2)) should not reject the null hypothesis. The second test is to confirm the dynamic effect in our model. In this test (AR(1)) the residuals should be correlated in first differences. Thus, giving an argument for using the GMM method. Additionally, STATA software reports the Hansen test for over-identification. Thus, the null hypothesis of this test is that the equations are properly over-identified, and the p-value has to be greater than 0.05 to confirm that our instruments are valid (Montero, 2010; Wintoki, 2012).

Table 5
Hypothesis 1a regression results. Incidence of accident rate, change in asset turnover, and past performance on return on assets (ROA) in the current year.

| | Static model | | | | | | | | | Dynamic model |
|---|---|---|---|---|---|---|---|---|---|---|
| | Baseline model | | | Full model | | | Model including year dummies | | | |
| | Pooled (1) | Random effects (2) | Fixed effects (3) | Pooled (4) | Random effects (5) | Fixed effects (6) | Pooled (7) | Random effects (8) | Fixed effects (9) | GMM System (10) |
| variables | | | | | | | | | | |
| ROA $_{t-1}$ | 0.0003<br>(0.00004) | -0.00005***<br>(0.00002) | -0.0001***<br>(3.36 e-06) | 0.024*<br>(0.0136) | 0.012*<br>(0.0069) | 0.006<br>(0.0046) | 0.021*<br>(0.0126) | 0.010<br>(0.0061) | 0.003<br>(0.0036) | 0.108<br>(0.2754) |
| ROA $_{t-2}$ | | | | | | | | | | -0.070<br>(0.2124) |
| Accrate | | | | 4.623***<br>(1.2650) | 2.860**<br>(1.1990) | 2.517*<br>(1.2873) | 4.174***<br>(1.1760) | 2.039*<br>(1.1832) | 1.436<br>(1.2772) | 55.263<br>(41.6297) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Change in asset turnover | 0.0001 (0.0004) | 0.0002 (0.0003) | 0.0004* (0.0002) | -0.0002 (0.0005) | -0.00003 (0.0003) | 0.0002 (0.0003) | -0.0003 (0.0005) | -0.0001 (0.0003) | 0.0002 (0.0003) | 0.017 (0.0681) |
| Intercept | -1.515*** (0.2034) | -2.523*** (0.2799) | -1.518*** (0.0001) | -1.693*** (0.2400) | -2.904*** (0.3363) | -1.586*** (0.0841) | -1.470*** (0.5392) | -0.360 (0.5545) | 2.953*** (0.5202) | -10.233*** (3.4724) |
| Year | | | | | | | | | | |
| 2009 | | | | | | | -4.211** (0.7596) | -4.195*** (0.6698) | -4.335*** (0.6795) | 1.809 (2.6346) |
| 2010 | | | | | | | -4.840*** (0.7716) | -5.909*** (0.6995) | -6.926*** (0.7100) | - |
| 2011 | | | | | | | -5.880*** (0.8099) | -7.986*** (0.7329) | -9.559*** (0.7445) | 1.141 (3.3914) |
| 2012 | | | | | | | -3.094*** (0.8309) | -5.965*** (0.7817) | -8.031*** (0.8068) | 4.292 (3.1781) |
| 2013 | | | | | | | -1.752** (0.8285) | -5.434*** (0.7730) | -7.742*** (0.7978) | 4.880** (2.1357) |
| 2014 | | | | | | | 1.549** (0.7831) | -2.362*** (0.7592) | -4.869*** (0.7932) | 7.299*** (1.8398) |
| 2015 | | | | | | | 4.780*** (0.7610) | 0.535 (0.7447) | -2.338*** (0.7863) | 9.659*** (2.2383) |
| 2016 | | | | | | | 6.603*** (0.7629) | 2.471*** (0.7321) | -0.447 (0.7813) | 11.965*** (2.8347) |
| 2017 | | | | | | | 7.105*** (0.7383) | 2.584*** (0.6931) | -0.804 (0.7438) | 11.015*** (3.9520) |
| Goodness of fit | F(2, 4439) = 0.37 | Wald chi2(2)=8.22 ** | F(4, 4439)= 429.25*** | F(3, 3780)= 5.98*** | Wald chi2(3) = 9.30** | F(3, 3780) = 2.23* | F(12, 18438) = 58.07*** | Wald chi2(12) = 428.61*** | F(12, 3780)= 29.84*** | F(12, 3091) = 40.17*** |
| R-squared overall | 0.001 | 0.004 | 0.004 | 0.007 | 0.007 | 0.007 | 0.041 | 0.059 | 0.024 | |
| N | 22665 | 22665 | 2665 | 18451 | 18451 | 18451 | 18451 | 18451 | 1851 | 14663 |
| Groups | 4440 | 4440 | 4440 | 3781 | 3781 | 3781 | | 3781 | 3781 | 3092 |
| AR (1) test (p-value) | | | | | | | | | | (0.557) |
| AR (2) test (p-value) | | | | | | | | | | (0.734) |
| Hansen test of over-identification (p-value) | | | | | | | | | | (0.419) |
| Diff-in-Hansen test of exogeneity (p-value) | | | | | | | | | | (0.661) |

Huber-White robust standard errors are in parentheses.
P < 0.01***
P < 0.05**
P < 0.10*

As we can see in Table 5, all accident rate coefficients are positive and significant (see columns 4-8), except when we fit the model with fixed effects estimators in the full specification with year dummies variables (see column 9), where the coefficient remains positive, but it loses its significance. These results are in the opposite direction to our hypothesis 1a statement, where we expected a negative effect of accidents rate on the company's profitability (ROA) in the same year.

In the full model and in the same one with the year dummies variables, the change in assets turnover has no significant coefficient in any model and specification. In the case of the past performance control variable, it is always positive, as we expected, and it has significant coefficients in the pooled estimation (0.024 p-value<0.10; and 0.021 p-value<0.10) and in the model with the random effects' estimations (0.012 p-value<0.10). Even when the parameter estimations remain positive, they are not significant in the rest of estimation methods.

Regarding the year dummies variables, we obtained negative and significant coefficients for variables from 2009 to 2013 in all estimations (pooled, random and fixed effects). This indicates a decrease in ROA during these years. It should be noticed that those years were the ones with the biggest impact of the economic crisis that specially affected the construction sector, with a serious reduction of the activity. From 2014 on, the year dummies estimated coefficients change their sign and significance between the different estimators. For pooled and random effects estimations methods they have a similar behaviour, but they have different results for fixed effect estimation method. Then, providing less robustness to these years results.

Regarding the GMM system estimation (column 10 Table 5), the AR(2) second-order serial correlation test yield a p-value of 0.734 which means that we cannot reject the null hypothesis of there is no second-order serial correlation. Concerning the Hansen J test of over-identifying restrictions, it has a p-value of 0.419 which means that we cannot reject the hypothesis that our instruments are valid. However, we do not find empirical evidence of the dynamic relationship between past performance and accidents. It is reflected in the AR (1) test in first differences, where the p-value is 0.55, then, the null hypothesis is rejected, indicating that there is not a dynamic relationship (Montero, 2010), thus the GMM system is not appropriate in our panel data.

Across models, more accidents are associated with higher profitability. According to the best-fitting model, which is random effect including year variables, for every one accident increase, the companies' profitability increases by an average 2.039. The analysis yields a very small size effect which reflects a reduced practical effect of accidents in decreasing the company's economic results.

Table 6 reports the results of the analysis of our hypothesis 1b, fitting our model 2, when the effect of past accidents is considered to affect the current profitability. In columns 1, 2, and 3 the complete model with the independent variable (accident rate) is presented in the three different estimation methods we have considered (column 1 – pooled; column 2 – random effects; and, column 3 – fixed effects). In columns 4, 5, and 6, the result of the model with the year dummies variables is shown. In this table and the following ones, we have not included the baseline model, as it is the same one that we have reported in Table 5.

As it can be seen in Table 6, for lagged accident rate we obtain similar results as in our first hypothesis (1a). We have found a positive and significant coefficient in all the estimation methods, in both models with and without year dummies variables (see columns 1-5), except when we estimate the panel data regression model with fixed effects and the year dummies variables (see column 6).

Regarding control variables, the parameter of change in asset turnover is negative in the pooled estimation, but positive in the random and fixed effects estimations, but it is not significant in none of the estimation methods. Past performance -by lagged ROA (profitability)- has a positive coefficient in all models and estimation methods, but it is only significant ($p<0.01$) for random and fixed effect estimation methods in the complete model and with the year dummies variables. Finally, regarding the year dummies variables, we have also obtained negative and significant coefficients from 2009 to 2013 consistently across all estimation methods. These results change from 2014 on, obtaining significant coefficients but with non-consistent signs across the different estimation methods.

Summing up, due to the significant and positive estimated effect of accident rate on ROA, our results do not support our hypothesis 1b that occupational accidents have a negative effect on the company's financial performance in the following year.

In all models, more accidents are related to higher profitability. According to the best-fitting model, the random effect estimator with year dummy variables, one more accident is linked with 2.103 more profitability. In this case, we have also found a very small size effect, this result limits the practical implications of the effect of accidents on the company's profitability.

Table 6
Hypothesis 1b regression results. Incidence of accident rate, Change in asset turnover, and past performance on profitability (ROA) one year ahead.

| | Full model | | | Including year dummies | | |
|---|---|---|---|---|---|---|
| LINEAR MODEL | Pooled (1) | Random effects (2) | Fixed effects (3) | Pooled (4) | Random effects (5) | Fixed effects (6) |
| variables | | | | | | |
| $ROA_{t-1}$ | 0.00001 (0.00002) | -0.00007*** (7.71e-06) | -0.0001*** (3.48e-06) | 2.62e-06 (0.00001) | -0.0001*** (6.61e-06) | -0.0001*** (2.80e-06) |
| $Accrate_{t-1}$ | 3.595*** (1.1660) | 2.326** (1.1141) | 1.971* (1.1919) | 4.253*** (1.1347) | 2.103* (1.1083) | 1.074 (1.1940) |
| Change in asset turnover | - 0.00002 (0.0005) | 0.0001 (0.0003) | 0.0003 (0.0002) | -0.0001 (0.0004) | 0.0001 (0.0001) | 0.0003 (0.0003) |
| Intercept | -1.981*** (0.2006) | -3.245*** (0.3285) | -1.872*** (0.0823) | -1.923*** (0.5563) | -1.009* (0.5675) | 2.363*** (0.5302) |
| Year | | | | | | |
| 2009 | | | | - 4.206*** (0.7106) | -4.207*** (0.6819) | -4.399*** (0.6947) |
| 2010 | | | | -4.612*** (0.75938) | -5.564*** (0.7105) | -6.614*** (0.7203) |
| 2011 | | | | -5.426*** (0.8008) | -7.108*** (0.7471) | -8.619*** (0.7580) |
| 2012 | | | | -3.340*** (0.8005) | -5.795*** (0.7604) | -7.822*** (0.7859) |
| 2013 | | | | -2.158** (0.8420) | -5.209*** (0.8017) | -7.395*** (0.8261) |
| 2014 | | | | 2.042** (0.7943) | -1.672** (0.7614) | -4.263*** (0.7947) |
| 2015 | | | | 5.219*** (0.7916) | 1.376* (0.7616) | -1.501* (0.7985) |
| 2016 | | | | 6.795*** (0.7838) | 2.732*** (0.7541) | -0.413 (0.8013) |
| 2017 | | | | 7.532*** (0.75835) | 3.175*** (0.7154) | -0.343 (0.7587) |
| Goodness of fit | F(3,18687)= 3.36** | Wald chi2(3) = 79.33*** | F(3,3789)= 265.14*** | F(12,3789)= 48.60*** | Wald chi2(11)= 580.12*** | F(12,3789)= 214.04*** |
| R-squared overall | 0.001 | 0.0004 | 0.0002 | 0.035 | 0.032 | 0.023 |
| N | 18691 | 18691 | 18691 | 18691 | 18691 | 18691 |
| Groups | | 3790 | 3790 | 3790 | 3790 | 3790 |

Huber-White robust standard errors are in parentheses.
$P < 0.01$***
$P < 0.05$**
$P < 0.10$*

The next step in our analysis is to check the possibility of a curvilinear relationship between accidents and profitability in the same year, our hypothesis 2a. The results of this analysis are reported in Table 7. In this case, we checked if an inverted U-shape is reflecting the relationship between accidents and the firm profitability. We expected to find a positive coefficient of the accident rate variable, and a negative coefficient of the quadratic accident rate term. In the results listed in Table 7 there is a positive and significant coefficient of the linear component of the accident rate variable in all the full model estimation methods ($p<0.01$ in pooled and random effects and p<0.05 in fixed effects estimations -columns 1-3 in Table 7-), and a positive and significant one in pooled and random effects estimations (columns 4-5 in Table 7) in the full model adding year dummies variables. Regarding the quadratic component of the accident rate variable, the results show a negative and significant coefficient in all methods when we estimate the full model and pooled and random effects with year dummies variables (columns 1-5 in Table 7). Also, the unique analysis in which the variables of interest (linear and quadratic accident rate) lose their significance is when fixed effects is conducted with the year dummies variables (see column 6 in Table 7). Thus, we obtained support for our hypothesis 2a. The increase in the company's profitability for lower accident rate levels is confirmed, while it decreases for larger accident rate levels.

The inverted U-shape is reflected in the model that best fit the data, the random effect estimator with year dummy variables. The rest of estimators yield the same effect providing support to the results. Although it should be noted that there is a very small size effect.

Table 7

Hypothesis 2a regression results. Incidence of accident rate, accident rate$^2$, change in asset turnover and past performance on profitability (ROA) in current year.

| | Full model | | | Including year variables | | |
|---|---|---|---|---|---|---|
| | Pooled (1) | Random effects (2) | Fixed effects (3) | Pooled (4) | Random effects (5) | Fixed effects (6) |
| variables | | | | | | |
| $ROA_{t-1}$ | 0.024* (0.0136) | 0.012* (0.0069) | 0.006 (0.0049) | 0.021* (0.0126) | 0.010 (0.0061) | 0.003 (0.0036) |
| Accrate | 7.821*** (1.7013) | 5.034*** (1.7624) | 4.479** (1.8963) | 6.772*** (1.6859) | 3.515** (1.7559) | 2.506 (1.8966) |
| Accrate$^2$ | -2.480*** (0.7616) | -1.604** (0.6271) | -1.422** (0.6275) | -2.006*** (0.7346) | -1.085* (0.6024) | -0.773 (0.6044) |
| Change in asset turnover | -0.0002 (0.0006) | -0.00003 (0.0003) | 0.0002 (0.0003) | -0.0003 (0.0005) | -0.0001 (0.0003) | 0.0002 (0.0003) |
| Intercept | -1.830*** (0.2079) | -3.001*** (0.3425) | -1.673*** (0.1091) | -1.642*** (0.5474) | -0.458 (0.5638) | 2.881*** (0.5323) |
| Year | | | | | | |
| 2009 | | | | -4.163*** (0.7602) | -4.171*** (0.6704) | -4.318*** (0.6799) |
| 2010 | | | | -4.740*** (0.7727) | -5.858*** (0.7008) | -6.890*** (0.7114) |
| 2011 | | | | -5.810*** (0.8111) | -7.951*** (0.7337) | -9.534*** (0.7452) |
| 2012 | | | | -3.010*** (0.83256) | -5.918*** (0.7845) | -7.997*** (0.8100) |
| 2013 | | | | -1.675** (0.8292) | -5.389*** (0.7739) | -7.708*** (0.7988) |
| 2014 | | | | 1.617** (0.7846) | -2.321*** (0.7620) | -4.838*** (0.7963) |
| 2015 | | | | 4.841*** (0.7621) | 0.572 (0.7465) | -2.310*** (0.7883) |
| 2016 | | | | 6.653*** (0.7635) | 2.504*** (0.7327) | -0.420 (0.7823) |
| 2017 | | | | 7.155*** (0.7394) | 2.616*** (0.6944) | -0.777 (0.7455) |
| Goodness of fit | F(4, 18446)= 6.39*** | Wald chi2(4) = 12.06** | F(4,3780)=2.20* | F(13,18437) = 53.81*** | Wald ci2(13)=429.13*** | F(13,3780)=27.56*** |
| R-squared | 0.008 | 0.008 | 0.007 | 0.041 | 0.036 | 0.024 |
| N | 18451 | 18451 | 18451 | 18451 | 18451 | 18451 |
| Groups | | 3781 | 3781 | | 3781 | 3781 |

Huber-White robust standard errors are in parentheses.

P < 0.01***

P < 0.05**

P < 0.10*

Similarly as we have proceeded before, we tested our last hypothesis, H2b, to know if there is a curvilinear relationship between yearly accidents and the company's financial performance in the following year. Table 8 shows the results we have obtained.

Table 8
Hypothesis 2b regression results. Incidence of accident rate, accident rate², change in asset turnover, and past performance on profitability (ROA) one year ahead.

| | Full model | | | including year dummies | | |
|---|---|---|---|---|---|---|
| QUADRATIC MODEL | Pooled (1) | Random effects (2) | Fixed effects (3) | Pooled (4) | Random effects (5) | Fixed effects (6) |
| variables | | | | | | |
| $ROA_{t-1}$ | 0.00001<br>(0.00002) | -0.0001***<br>(7.70e-06) | -0.0001***<br>(3.47e-06) | 2.44e-06<br>(0.00001) | -0.0001***<br>(6.60e-06) | -0.0001***<br>(2.80e-06) |
| $Accrate_{t-1}$ | 5.274***<br>(1.6166) | 3.414**<br>(3.4141) | 2.952*<br>(1.6765) | 6.020***<br>(1.5985) | 2.847*<br>(1.5756) | 1.355<br>(1.6874) |
| $Accrate_{t-1}^2$ | -1.193***<br>(0.4658) | -0.738*<br>(0.4099) | -0.659<br>(0.4323) | -1.244***<br>(0.4529) | -0.501<br>(0.3885) | -0.187<br>(0.4125) |
| Change in asset turnover | -0.00002<br>(0.0005) | 0.0001<br>(0.0003) | 0.0003<br>(0.0002) | -0.0005<br>(0.0005) | 0.0001<br>(0.0003) | 0.0003<br>(0.0003) |
| Intercept | -<br>2.060***<br>(0.2093) | -3.297***<br>(0.3341) | -1.919***<br>(0.1045) | -2.051***<br>(0.5618) | -1.062*<br>(0.5730) | 2.342***<br>(0.5372) |
| Year | | | | | | |
| 2009 | | | | -4.193***<br>(0.7688) | -4.203***<br>(0.6817) | -4.398***<br>(0.6946) |
| 2010 | | | | -4.567***<br>(0.7847) | -5.547***<br>(0.7111) | -6.609***<br>(0.7208) |
| 2011 | | | | -5.349***<br>(0.8201) | -7.080***<br>(0.7480) | -8.609***<br>(0.7587) |
| 2012 | | | | -3.285***<br>(0.8018) | -5.773***<br>(0.7611) | -7.814***<br>(0.7868) |
| 2013 | | | | -2.093**<br>(0.8459) | -5.182***<br>(0.8034) | -7.385***<br>(0.8281) |
| 2014 | | | | 2.104***<br>(0.7833) | -1.646**<br>(0.7618) | -4.253***<br>(0.7954) |
| 2015 | | | | 5.278***<br>(0.7781) | 1.400*<br>(0.7624) | -1.497*<br>(0.7992) |
| 2016 | | | | 6.846***<br>(0.7793) | 2.754***<br>(0.7534) | -0.405<br>(0.8005) |
| 2017 | | | | 7.577***<br>(0.7600) | 3.194***<br>(0.7154) | -0.336<br>(0.7587) |
| Goodness of fit | F(4,18686)=<br>2.82** | Wald chi2(4)=<br>79.92*** | F(4,3789)=<br>199.94*** | F(13,18677)=<br>54.33*** | Wald chi2(13)=<br>580.75*** | F(13,3789) =<br>198.03*** |
| R-squared | 0.001 | 0.001 | 0.0003 | 0.035 | 0.032 | 0.023 |
| N | 18691 | 18691 | 18691 | 18691 | 18691 | 18691 |
| Groups | | 3790 | 3790 | | 3790 | 3790 |

Note: Huber-White robust standard errors are in parentheses.
P < 0.01***
P < 0.05**
P < 0.10*

The results are similar to those obtained for the hypothesis 2a, but less robust across the different estimation methods for the quadratic term of accident rate. As it is shown in Table 8, a positive and significant coefficient in all estimators and models can be seen for the linear term of accident rate (see columns 1-5), except when fixed effects with year dummies variables are considered (see column 6). For the quadratic term of accident rate, we found negative coefficients in all models and estimations but only significant in the full model for pooled estimation with and without year dummies (see columns 1 and 4 in Table 8), and for random effects estimation without year dummies (see column 2 in Table 8). Although these results show slightly lower robustness across different estimation methods than those obtained in the testing of hypothesis 2a, they maintain the sign that gives support to the non-linear relationship between a company's accidents and its ROA in the following year, suggesting that the quadratic effect lasts in a period of time. The inverted U-shape is reflected in the model considering all estimators methods except fixed effect without year dummy variables. The model that best fit the data is the random effect estimator with year dummy variables. In this case, the quadratic term of accident rate maintains its negative sign, but it loses its significance. Furthermore, the very small size effect indicates a reduced impact of accidents on the company's profitability in the following year.

Although the estimated effect is very small, past companies' financial performance has significant ($p<0.01$) and negative coefficients in random and fixed effects estimations in the models with and without year dummies (see columns 2-3 and 4-5 in Table 8). In pooled estimations, it has positive but not significant coefficients. Similar to our results for hypothesis 2a, the variable change in asset turnover is not significant in any model and estimation methods.

Finally, the results of the test of hypothesis 2b reported in Table 8, show consistent negative and significant coefficients of the year dummies variables from 2009 to 2013. In later years, from 2014 to 2017, the significance and the sign changed depending on the different estimation methods. These results confirm the negative impact of these years on the companies' economic performance, reflecting the influence of the economic crisis that were especially intense between 2009 and 2013 in the construction sector.

***Quadratic function confirmation test***

Up to this point, the results support the hypotheses that argued for a non-linear relationship, as the significance of the quadratic variable of interest (accident rate) was supported. Then, we want to check whether the relationship between ROA and accidents is explained as a quadratic function and if it adopts an inverted U shape, as Forteza et al. (2017a) stated. To do this, we have followed the methodology of Lind and Mehlum (2010), used by Argilés-Bosch et al. (2020) instead of the estimation method testing the significance of the difference between predicted ROA at the tipping point and the predicted ROA at their maximum accident rate that Forteza et al. (2017a) conducted.

Lind and Mehlum (2010) stated that to claim a U or an inverted U shape is not enough to confirm the significance of the quadratic term of the variable of interest. They posit that there could be a convex but monotonous relationship between the variables of study due to its confidence range limits the data to a part of the curve. If this is the case, it is possible to think that there is a tipping point within the range of the variable, thereby claiming a U shape. Hence, we have conducted the U-test and the Fieller test to establish the confidence interval at 95% to confirm the real shape of the relationship between accident rate and ROA in our data.

The next figures show the graphics of the predicted ROA according to the estimated quadratic function of ROA on accident rate in the same year, in the three estimation methods we have performed in the analyses. The predicted maximum profitability is 4.295 and it is attained at 1.576 of accident rate in pooled estimation (see Figure 3). In random effects estimation, the predicted maximum ROA is -3.762 and it is attained at 1.569 of accident rate (see Figure 4). For the fixed effects estimation, the maximum ROA is 0.851 and it is attained at 1.574 of the accident rate (see figure 5). These charts should not be misunderstood. Greater economic profitability is not associated with having a certain number of accidents. As has been reflected in the literature review, from a strictly economic point of view there is a certain level of risk that finds the optimum point for the company between accident costs and accident prevention costs. Although this should not be the company's safety objective, since there are many other points of view that should be considered, such as the health of the workers themselves, their families, as well as society, which is affected by the cost it must assume for each accident and sick leave reported. If all the costs were reflected in the company's accounts, the effect of having to assume them would affect the final economic results to a greater extent.

Figure 3.
Pooled estimation of the incidence of accident rate, and accident rate$^2$ on return of assets (ROA) in the same year, with the minimum and maximum bounds for the tipping point of the Fieller test interval at 95%.

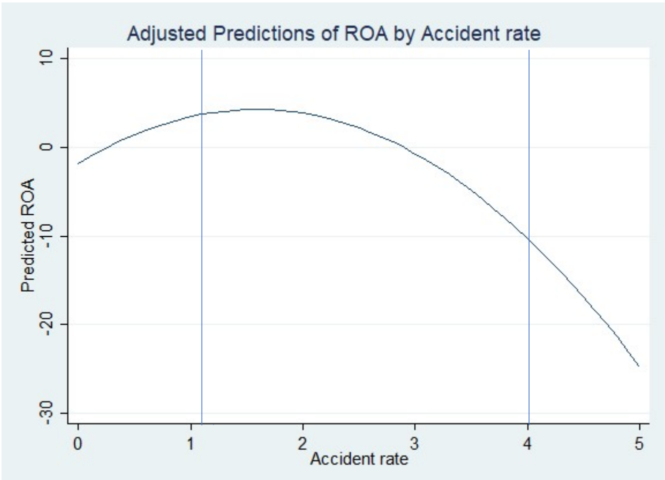



Figure 4.
Random effects estimation of the incidence of accident rate, and accident rate$^2$ on return of assets (ROA) in the same year, with the minimum and maximum bounds for the tipping point of the Fieller test interval at 95%.

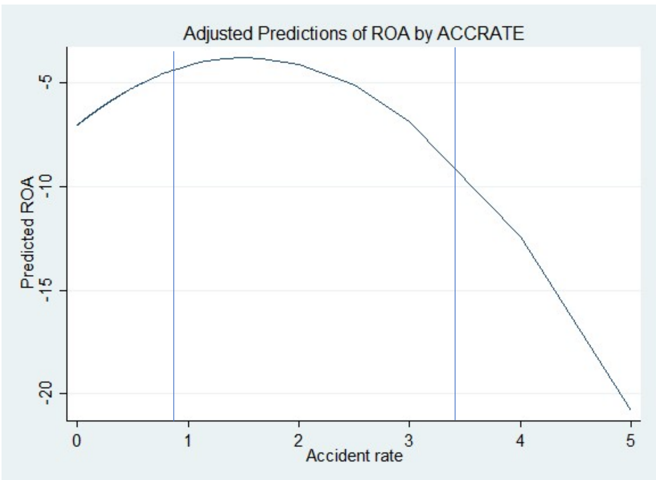



Figure 5. Fixed effects estimation of the incidence of accident rate, and accident rate$^2$ on return of assets (ROA) in the same year, with the minimum and maximum bounds for the tipping point of the Fieller test interval at 95%.

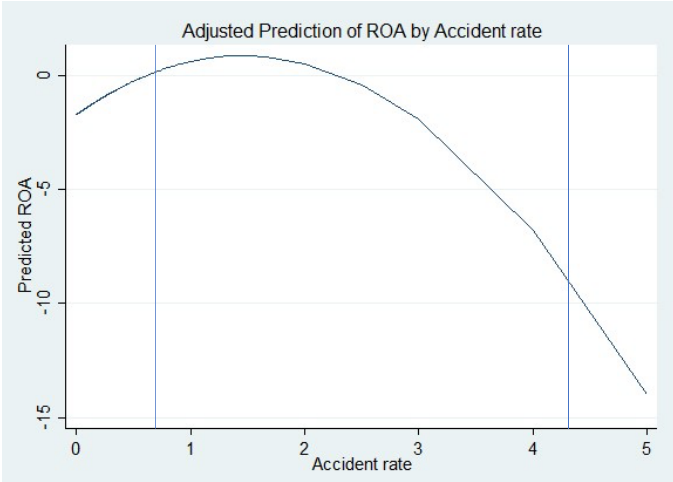



Table 9. Fieller test results.

| | accident rate and ROA in currrent year | | | accident rate in ROA one year ahead | | |
|---|---|---|---|---|---|---|
| | Pooled (1) | Random effects (2) | Fixed effects (3) | Pooled (4) | Random effects (5) | Fixed effects (6) |
| variables | | | | | | |
| Accrate | 7.821*** (1.7013) | 5.034*** (1.7624) | 4.479** (1.8963) | 5.274*** (1.6166) | 3.414** (3.4141) | 2.952* (1.6765) |
| Accrate$^2$ | -2.480*** (0.7616) | -1.604** (0.6271) | -1.422** (0.6275) | -1.193*** (0.4658) | -0.738* (0.4099) | -0.659 (0.4323) |
| Accrate with maximum ROA | 1.576 | 1.569 | 1.574 | 2.419 | 2.842 | 3.619 |
| Fieller test (t-value) | 2.15** | 2.23** | 2.03** | 1.93** | 0.83 | 0.19 |
| Fieller test interval at 95% extreme point | (1.11; 4.02) In range | (0.92; 3.41) In range | (0.71; 4.29) In range | (1.69; 5.13) upper bound out of range | Out of range | Out of range |

As can be seen in Table 3, the accident rate variable in our sample ranges from 0 to 5, with a mean of 0.07. It must be considered that our sample of all companies with economic information in SABI, includes all companies, with or without reported accidents, and all categories (minor, serious, and fatal accidents). Since we have obtained significant coefficients in our quadratic specification estimations in the three estimation methods, we performed the U-test recommended by Lind and Mehlum (2010), together with the Fieller test, to identify if it is a U shape instead of a concave but monotonous curve. The results are shown in Table 9. For the relationship between the accident rate and the company's profitability in the current year (columns 1-3 in Table 9), all the tests are significant at a p-value < 0.05, and the maximum point is in the range of the accident rate variable in all cases. Hence, we conclude that we can confirm the inverted U shape of ROA as a function of the accident rate. Conversely, the results of U-test and the Fieller test, in the analyses of the effect of the accident rate on profitability one year ahead, show that the U-shape is not confirmed in any estimation method. In pooled estimation the test was significant but the upper bound of the confidence interval is out of the distributional range of the accident rate variable.

## 4.5. DISCUSSION

Concerning the proper model to estimate our data, we have not found support for the dynamic relationship derived from the inclusion of the past performance variable in our model as an independent variable. We ran the Arellano–Bond tests for first- and second-order of serial correlation in the first-differences (AR(1), AR(2)) to check a possible endogeneity problem. As Wintoki et al. (2012) stated, many economic studies have to deal with endogeneity issues derived from the complex relationship among the economic variables, where it is usually complicated to establish whether there is a unidirectional or reverse causality relationship between the variables. In our analysis, the results of the first differences test (AR1) in the Arellano-Bond test imply that the relationship between our variables is not dynamic. In this case, the static models would provide reliable results, especially, when the traditional fixed effects method is used, as "it can potentially ameliorate the bias arising from unobservable heterogeneity" (Wintoki et al., 2012). Although this test has not met the dynamic relation in our data, we think it is important to carry it out, and we recommend conducting it whenever an endogeneity problem may exist, in order to avoid bias and obtain robust results. It should be noted that our model could have been affected by endogeneity as we included the past value of ROA in our model, to replicate the model of reviewed studies, in order to make possible a comparison of all them. Moreover, when we observed the Pearson correlations matrix (Table 4) there was a low but significant correlation between past performance and accidents. Wintoki et al. (2012) argued that fixed-effect method results will be biased if the panel's time dimension is small and our explanatory variables are not strictly exogenous. Consequently, we conducted the aforementioned tests to verify the relationship among our variables, their results reinforce those attained with static models.

Regarding our results, more occupational accidents are related with a higher company's financial performance in the same year in all models and estimation methods, this significance disappears just when regression is performed with fixed effects and the year dummies variables are included in the model. It should be noted that the economic company's performance, represented by ROA, is affected by company-specific and external factors. A possible reason for this loss of significance is that some external factors -not included in our model- are influencing the economic companies' performance and the relationship between our variables. In our analyses, we have included construction companies' data from 2007 to 2017, which includes the period of the economic crisis, that strongly affected the construction sector, and also the recovery period.

Following the debate of the three previous studies that focused on the effect of occupational accidents on the company's profitability, one of the most salient aspects is the difference they found in the sign of this relationship. Argilés-Bosch et al. (2014; 2020) found evidence of the effect of occupational accidents in reducing the company's profitability, arguing that occupational accidents disrupt the company's operations, affecting productivity and finally the company's economic performance. Conversely, Forteza et al. (2017a) obtained evidence in the opposite direction, since their empirical analysis shown that for a range of lower accident rates the profitability increases when more accidents are reported, and that this relationship changes for large levels of the accident rate, implying a reduction in the companies' profitability. As we have seen in the results section, our results are in line with those achieved by Forteza et al. (2017a), since we have also found that the company's profitability rises while the accident rate increases. Therefore, we have also proposed the quadratic specification to test if this effect changes for higher levels of the accident rate.

As for the long-term effect analyses, when we study the effect of accidents on the company's profitability in the following year, we found similar results as those obtained in the short-term effect analysis. The accident rate does not show an impact in reducing ROA in all models and estimations. Our results do not provide support for Argilés-Bosch et al.'s (2014; 2020) hypothesis of a stronger effect of accidents on the company's economic results in the following year. They argued that the impact that accidents have on the company's profitability does not manifest itself in the short term, because managers and workers can minimize the immediate effect with their effort working on urgent tasks. Our results are consistent with Forteza et al.'s (2017a) ones, as they also found no support for Argilés-Bosch et al.'s results of this long-term effect.

Considering the results of our models (1) and (2), we estimate our models (3) and (4) in order to analyze if this profitability increases for a low levels of the accident rate but it is reduced for higher levels of the accident rate. Our results are consistent with our hypotheses 2a and 2b across the different estimation methods when the full model is considered. The results show a negative quadratic coefficient and the positive linear coefficient, suggesting a concave curve, thereby a possible inverted U.

We conducted the analyses to test the shape of our variables relationship by using the methodology recommended by Lind and Mehlum (2010), as Argilés-Bosch et al. (2020) did in their latest study. The results confirmed an inverted U-shape in the same year of accidents and profitability analysis (hypothesis 2a). The profitability increases for a low level of accident rate until a tipping point is reached where more accidents reduce the company's profitability. That is to say, there is an increase in profitability until a certain number of accidents. Specifically, in the case of random effect estimation (see column 2 in Table 9), the tipping point is achieved at an accident rate of 1.569, the Fieller test was significant and the bounds of the Fieller interval at 95% were (0.92; 3.41), which implies that there were in the range of our accident rate variable. We found similar results for the fixed effect estimation (see column 3 in Table 9), in this case the tipping point is achieved at an accident rate of 1.574, the Fieller test was significant too and the bounds of the Fieller interval (0.71; 4.29) were in the range of the accident rate variable. Although this accident level is high, the results also show that when a certain point of accident rate is reached by a company, then its profitability decreases, changing the direction of the relationship among our variables. These results provide support to those reported by Forteza et al., (2017a) in the sense that they confirm the U-shape relationship between accident rate and profitability in the same year, and this effect has been confirmed conducting the analyses with Lind and Melhum's methodology proposed by Argilés-Bosch et al. (2020) instead of the limits slope verification that Forteza et al. (2017a) conducted. Although these results do not provide support to those achieved by Argilés-Bosch et al. (2020), since they posit the linear function hypothesis in contrast to the quadratic relationship between accident rate and ROA, they can explain the different sign that we have found in the relationship between accidents and profitability. It should be noted that the sample of Argilés-Bosch et al. (2014) included 300 companies (100 from each industry they studied) considering all companies reporting fatal accidents, then companies reporting serious accidents and finally, their sample was completed with companies reporting minor accidents. According to their study, the mean of their accident rate variable in the construction sector was 12.1% of workers injured with respect to the company's total workforce. In this case, they included in their study the companies most affected by accidents and, therefore, they could be reflecting the negative effect we have found on profitability for high levels of accidents.

Regarding the U shape relationship among accidents and the profitability of the following year, the results do not confirm at all this inverted U-shape relationship in the analysis in long term effect of the accidents on the company's profitability. These results are in line with those achieved by Argilés-Bosch et al. (2020). In this last case, the t-value was significant but the extreme point was out of the range of the accident rate variable, thus, a monotone concave curve is reflected.

A possible difference that may explain our different results from those of Argilés-Bosch et al. (2014; 2020) is that we focus our study on the construction sector, with data of 3.781 construction companies in the Balearic Islands, while they include several sectors in their studies. The samples of our study and the samples of Argilés-Bosch et al.'s studies were quite different. Their first study had a sample of 299 companies pertaining to building, household repair, and metallurgical sectors (Argilés-Bosch et al., 2014), and the second study was performed at the sector's level, in 6 different sectors (manufacturing, electricity, water supply, construction, wholesale, retail and trade, and transportation) (Argilés-Bosch et al. 2020). It should be noted that the sample of this last study was at the sector level, without data at company level, as in the previous study. In Argilés-Bosch et al. (2020), their results show the evolution of the median profitability according to the median value of each sector's accident rate. We also found relevant differences regarding the time span of the panels used in the three previous studies and ours. In our analyses, we have a long panel data of 11 years (2007—2017) which includes the period of the economic crisis, that strongly affected the construction sector, and also the recovery period. In Argilés-Bosch et al. (2014) they constructed a panel data of 5 years (1998—2003), which was a booming period in the construction sector. Forteza et al.'s (2017a) panel run from 2004 to 2009, and therefore it contained the initial years of the big global economic recession that lasted from 2007 to 2013. These authors recognized explicitly that their results could well be affected by the exogenous influence of the economic crisis. Finally, the Argilés-Bosch et al.'s (2020) study analyzed a panel from 2008 to 2018 which is similar to ours as it contains the economic crisis and recovery periods. As we have seen in the literature review section, the economic cycles have an impact on occupational accident reports due to the work load variations, the increasing demand for temporary workers, which use to be more inexperienced ones, and that there are different incentives for workers and employers to declare the accident. The trend shows that accidents decrease when there is an economic recession and increase rapidly when the economic experience an expanding period. These different sample sizes, types of companies, types of accidents included in the samples, industrial sectors, and the time span of the panels of each study may provide reasonable explanations for the different results of all these studies, which focus on the same specific issue from different perspectives.

Our results for low accident rates indicate that the economic argument alone is not enough for managers of construction SMEs to decide to implement the necessary safety culture within the company. This argument is consistent with those reported in other studies, which argued that the negative effect of accidents on the company's economic results is too weak to change the current situation of construction companies in front of safety issues. (Gosselin, 2004; Jallon et al., 2011; Ibarrondo-Dávila et al., 2015).In this sense, and according to the results obtained, if managers decide their investment in safety under the paradigm of profit maximization, the optimal decision will not be adjusted to the minimum possible level of accidents.

Likewise, we have to consider that managers do not really know the cost of accidents, as they are not completely reflected in the economic companies' analyses (EU-OSHA, 2017; Cagno et al. 2013, Micheli et al., 2015). Therefore, they cannot be considered in the decision-making process (Schulte et al. 2017). And this situation is difficult to change considering that the construction companies have their own characteristics and it is not prone to new approaches (Boadu et al., 2020). There are several reasons why the safety costs (prevention, protection, and accident costs) are not considered enough by the managers. Companies do not account for the real data -in quantity and quality- of the safety investment they do, or their occupational accident costs. All these costs are underreported and underestimated, especially in SMEs, as most of them do not have a human resources department and the manager or the owner is who has to carry out these tasks. This affects the accuracy of the economic analysis taking into account all the relevant expected cost associated with occupational accidents and it also limits conducting deeper research to obtain the impact of having accidents on the companies' results and draw conclusions. More empirical and theoretical studies are needed to better understand the real economic consequences of occupational accidents and injuries on the company's performance and on the countries' economic competitiveness.

In recent works, some methods to estimate accident costs are proposed (Micheli et al., 2021), but there is a need to standardize the data that have to be included and the methodology to report and account for them (Schulte et al., 2017; Takala et al., 2014). To carry out a complete economic analysis of safety investment all resources allocated to it must be considered, which include prevention, protection, and accident costs. With regards to these latter ones, as we discussed before, it should be noted that the companies do not consider them to affect the company's economic results (Gosselin, 2004; Jallon et al., 2011). As the companies should not pay the total cost of the accidents they reported. To carry out a complete accident cost analysis, it is important to consider all the companies and public system contributions and compensations for the accidents. It must be borne in mind that there is a notable difference in the way that a company has to face the payment of all the accident costs depending on the country where it takes place. Nowadays, developed countries have compensation schemes for occupational accidents and injuries. But the way of contributing to these schemes differs widely by country. In most cases, it is funded through the pooling of financial contributions by employers. Therefore, the costs that the public benefits scheme assumes together with the amount the companies have to pay to have these benefits should be taken into account. In Europe, the rate of contribution differs regarding the country from 0.5% to 4% (in Sweden, all the employers pay the same amount for each worker, while in Spain or France, the degree of risk in different industries is reflected in what they have to pay - Employment Injury benefits, ILO).

Although there are empirical studies highlighting several benefits to the company from its economic investment in OSH (Cagno et al. 2000), the actual accident economic impact on profitability does not lead to paying more attention to accident prevention investment. We think that to reach a real advance in the compliance of safety policies, especially in SME's companies, the accurate accident total costs estimation must be promoted by the Governments and the public administrations. A global agreement and commitment are needed. There are several options to promote this safety culture. On the one hand, there is a set of initiatives aimed to push companies for endorsing an OSH commitment, such as governments including some obligations in legal dispositions to regulate it and to establish a new framework for occupational and safety health, or improving managers' commitment by providing some extra fiscal benefits or economic aids to companies that achieve the objective of reducing accidents. With these initiatives, managers must see the opportunity to increase the company's economic results (ENWHP, 2009), since they will probably not see the need for any change while the profitability of the company is positive or when there is not a clear opportunity for raising benefits. In doing so, these measures will help those companies committed to safety to be more profitable. On the other hand, penalizing measures for less safe companies could be increased: more safety inspections on sites, higher fines for safety deficiencies that expose workers to higher risks, reviewing their contributions to the social security system or the employment injured scheme, and private insurance. These kinds of measures or others of similar nature could mean a real threat to the economic viability of those non-safety companies.

In addition to the economic argument, there is a legal obligation of the employer to protect his/her workers' health and to allocate all the necessary preventive resources and protection measures for a safe workplace. This argument seems not to be very much considered by Spanish construction company's managers, as the safety culture is not integrated in most of the construction Spanish companies (Segarra et al., 2017). Even when the Risk Prevention Law (LPRL 31/95) passed on 1995 and its developing regulation for the construction sector is in force since 1997 (RD 1627/97). This situation is also similar in the rest of the world (Alasamri et al. 2012), and some studies pointed out that the problem with the prevention works in many companies is that they are based mainly on formal paperwork compliance instead of real preventive actions (Swuste et al, 2012). To improve the safety culture within the company a complete commitment of all the organization is necessary, which must start from the managers (Fernández-Muñiz et al. 2009). As some empirical studies have demonstrated, implementing a safety management system will help involve all the staff in the needed safety culture, which may help achieve better economic and financial results through improving the safety climate and communication, reducing work absenteeism, and consequently increasing labor productivity (Fernández-Muñiz et al. 2009).

## 4.6. CONCLUSIONS

In this study, we focus on the relationship between the accidents reported by a company and its economic results, following the debate initiated by Argilés et al. (2014; 2020) and Forteza et al. (2017a). A priori, we stated our hypotheses to check if experiencing more accidents has a negative effect on companies' profitability.

One of the main objectives of this study was to clear up the discussion started by Argilés et al's studies (2014;2020) and Forteza et al. (2017a). On the one hand, we have obtained the same positive sign in the results of the relationship between the yearly accidents of a company and its economic performance as Forteza et al. (2017a), reflecting the possibility of increasing the profitability at the same time that accidents raise. On the other hand, we pretend to confirm the shape that best represents the relationship between accidents and company profitability. In this sense, we have obtained robust support for our main hypothesis and confirmation of the results obtained by Forteza et al. (2017a), as an inverted U shape has been confirmed. Reflecting that the profitability increases when the accident rate rises, until a limit of the accident rate when the company's profitability starts to decrease. To this end, we have used a longer panel of data including the crisis and post-crisis years and with a larger sample of companies to perform the analyses. In addition, the robustness of this result is confirmed by using the methodology used in previous empirical work where confronting results were found.
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Due to the robustness of the results obtained, we believe this study contributes to understand the complex links between safety and the economic company's performance. We offer empirical evidence about the insufficiency of economic arguments to answer the high levels of accidents in the construction sector. Therefore, more initiatives must be considered to improve the accident rate in this sector due to the workers and the social implications they have.

To sum up, company managers and governments decision-makers are not sufficiently aware of the actual costs of non-prevention policies and practices, as to the social and economic costs of occupational accidents. Therefore, changes are needed in the current system of accident costs and compensations. The construction company managers have to change their minds to support the need to address the OSH situation, to protect their workers' health and well-being. This requires promoting a real commitment that must start at the top of organizations, helping companies to acquire a safety approach in a proactive way, and succeed in it.

**Limitations and future lines of research**

This study has some limitations, as we did not specifically account for the costs of reported accidents. At present, it is not possible to know the actual investment in OSH by companies (including accident costs), as companies are not required to include it in their economic performance reports. Then, we have checked the companies' profitability by accounting for the accidents they reported in a year. Besides, the available data on accidents are not complete because all of they are not reported, especially for minor accidents. It is important to consider that, in most cases, managers do not see the need to report them if there is no human resources' structure to do it (EU-OSHA, 2017). In addition, the procedures for notifying occupational accidents do not collaborate to make the process more agile, as they are sometimes complicated for the company's safety structure.

Another limitation is the R-squared values of the estimated models are low, and consequently, the results and conclusions should be taken cautiously. The presented conclusions are drawn upon a specific sample, and our results and conclusion cannot be generalized due to the differences in the costs of treatment in the companies and also in the way that countries provide the accidents cash and benefits through their social protection system.

As for future lines of research, it would be very interesting to carry out a study of companies that do have integrated prevention systems, even if they are not mandatory, in order to carry out a detailed study of accident costs and their effects on the company. On the other hand, and considering that, according to our results, prevention does not have a determining effect on the economic results of companies for low levels of accidents, it would be necessary to draw up a scheme of the elements to be considered by managers in order to better protect the health of their workers, maximizing the results with the resources available to the company.

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# 5. Why is the construction sector failing in protecting its workers' health?

**ABSTRACT**

Physical and mental problems increase every year due to occupational accidents and diseases. To control them, safety climate at work is a well-identified critical factor. The usefulness of the safety climate measurements depends on their capability to represent the reality of the companies, including as many characteristics as possible. The literature has not provided a widespread model that can reflect the safety climate for different industries and companies. This study focuses on the construction sector, one of the sectors that most affects the workers' health. It proposes a theoretical model to measure the direct and indirect effect of safety climate on workers' physical and mental health mediated by job satisfaction. We suggest a multidimensional construct of safety climate, considering the most salient factors in the related literature and including psychological capital as a new factor that affects the workers' perception of safety climate. Job satisfaction includes working conditions, job rewards and compensations, and work-life balance. In this study, we used the last wave of the European Working Conditions Survey (2015), which has data from the construction sector in Spain. The proposed model was validated by using structural equation modeling. Our results pointed out that to further improve mental health in construction workers, it is necessary to first emphasize the importance of work-life balance, second, job rewards and compensations, and safety climate. As for physical health, it is crucial to control both safety climate and work-life balance. Eventually, we present some recommendations to construction companies' managers, letting them know the different items that have to be controlled to improve their results by establishing a ranking of all the variables that explain safety climate.

KEYWORDS: Safety Climate; Job satisfaction; Worker's health; Mental health; Physical health

## 5.1. INTRODUCTION

Why is the construction sector failing in protecting its workers' health? The construction sector shows no significant improvement in its results on accidents (Eurostat, 2020). This failure could be due to the fact that companies in the construction sector have their own way of doing the work, which differentiates them from companies in other industries. Moreover, changes are difficult to implement in the construction sector due to systemic and cultural reasons (Kramer et al., 2010). In the particular context of Spain, most construction companies have not integrated safety culture within the organization (Segarra et al., 2017). Furthermore, in most cases, productivity is still the first company's goal to achieve (Hofmann and Stetzer, 1996), and safety is often seen as a bureaucratic task to be done to accomplish the law and refuse some possible fines (Choudhry, 2009; Fernandez-Muñiz et al., 2009; Forteza et al., 2017).

In 2019, in the European Union (EU) 3,408 occupational fatal accidents occurred and 3.1 million non-fatal accidents resulted in at least four days of work leave. There was an increase of 76 deaths and 16,122 non-fatal accidents compared to the previous year. Within the EU-27, 22.2% of all these fatal accidents and 11.8% of non-fatal accidents took place within the construction sector. That is, the highest incidence of non-fatal accidents at work was observed in the construction industry, with 3,211 accidents per 100,000 persons employed (Eurostat, 2019a). Regarding diseases, there is only one experimental European statistics database with aggregated data for all the Members of the UE-27 (Eurostat, 2019b). In Spain, there is a database from the Ministry of Inclusion, Social Security and Migrations of the Spanish Government that reflects a downward trend from 2010 to 2014, going from 839 diseases reported in the construction sector workers in 2010 to 516 in 2014 (-38,50%), reflecting the activity decrease by the global economic crisis, and an upward trend from 2015 to 2019, going from 516 diseases reported in the construction sector workers in 2014 to 943 in 2019 (+82,75%), recovering and exceeding the pre-crisis level. In 2020, there was a reduction due to the Covid-19 pandemic that limited work and, consequently, the reported health problems. With these figures, the construction sector is one of the industries with the higher accident and disease rates, affecting the workers' health and their well-being, thereby their quality of life. This loss of life quality means a very high price to pay for workers, their families, companies, and society. The reality of occupational accidents and diseases reflects that it is a problem to tackle and that there is much work to be done.

Improving occupational health and safety and protecting the workers' health is one of the main goals of the EU institutions (art.153 of the Treaty on the Functioning of the European Union states). In this line, in June 2021, the EU institutions approved the strategic framework on health and safety at work (2021—2027), highlighting that one of the actual key objectives is the need to improve the prevention of workplace accidents and diseases.

There are many safety approaches used by companies and researchers to determine the safety commitment of a company. Safety culture and safety climate have been deeply studied to help establish internal factors that a company can manage to integrate safety within its processes and tasks and improve its safety outcomes such as workers' safety performance, and health (Casey et al., 2017). Safety culture refers to the value placed on safety in a company during the time, represented by its safety policies, management procedures, and actions (Guldenmund, 2000). Safety climate is defined as workers' perceptions about the importance of safety in their company (Bergheim et al., 2015; Zohar, 2014). It is a snapshot at a particular point in time of some aspects of the company's safety culture. Managers' decisions can improve, first, the safety climate, and if these practices and efforts are constant over time it can lead to a positive safety culture. Safety culture requires multiple methods of assessment over a long period of time, and it requires more time to be modified. Safety climate can be measured formally using survey tools designed to assess an individual's response to key areas of safety, it is strongly influenced by some organizational safety decisions and group social norms (Bergheim et al., 2015). Safety climate is recognized as a key factor for improving safety outcomes such as workers' safety performance and health (Choudhry et al., 2009; Clarke, 2010). Zohar (1980) was the first author to introduce the safety climate concept in the research literature. Most of the literature has demonstrated a relationship between some aspects of the daily task conditions, safety climate, and safety outcomes such as accidents or diseases. Although the literature has evolved since Zohar's seminal work, it is essential to continue researching how safety climate affects safety performance and thereby workers' health, specifically in the construction sector (Choudhry et al., 2009; Han et al., 2021; Luo, 2020).

Therefore, it is important to understand better how to improve the workers' health. We believe that it is necessary to carry out research that provides implications that can help policy-makers and managers to make decisions, and that also provides clear and practical ideas that could be implemented in the tasks carried out by small and medium-sized companies. These implications should be useful for the daily planning and organization of the works, paying particular attention to safety climate. Furthermore, these implications must serve to persuade the managers to spread the safety approach to all the agents that participate in the organizational process. In this way, a healthy working environment can be achieved, thereby protecting workers' health.

In this paper, we focus on the study of the relationship between safety climate and workers' health through job satisfaction. In doing so, we have carried out empirical research using data from the European Working Conditions Survey for the Spanish construction sector. The objective is to find the key elements of all these variables and their relationships to obtain a safety working environment, and improve workers' health.

The structure of this study is organized as follows: First, we review the related literature and develop our hypotheses. Second, we describe the data, our sample, and methodology. Third, we present the results, which are also discussed. Finally, we offer our conclusions.

## 5.2. LITERATURE REVIEW AND HYPOTHESES STATEMENT

Since the early '80s, it has been a lot of literature focused on safety climate and the different ways in which it can affect safety performance (Chen et al., 2021; Schwatka et al., 2016) and its relationship with some objective outcomes such as accidents (Ajslev et al., 2017; Aliabadi et al., 2020). Safety climate is a well-established concept to measure the company's approach to safety by its worker's perceptions in different industries and sectors as health (de Lima Silva Nunes et al., 2021), petrochemical industry (Karimpour et al., 2021), cement industry (Borgheipour et al., 2020) and construction sector (Andersen et al., 2018; Choudhry, 2009), among others.

Although there is great consensus on safety climate affecting safety outcomes, researchers have faced the studies in many different ways, considering different variables and methods. For example, Neal and Griffin (2006) conducted a longitudinal study linking group safety climate positively with individual safety motivation, with self-reported safety behavior negatively related to accidents. In that study, they pointed out a limitation in safety climate measures because they focus on individuals' safety perceptions but did not focus on safety issues at a group level such as supervisory practices. Clarke (2010) proposed a relationship model between safety climate and occupational accidents, considering job satisfaction, health and well-being, and safety behavior as mediator variables. This author proposed and tested a broad model by carrying out a meta-analysis. Both studies, Neal and Griffin's (2006) and Clarke's (2010), included psychological climate, which is defined as individual employee perceptions of their work environment considering some job, role, group, leader, and organizational attributes (Clarke, 2010), as a determinant factor preceding safety climate. Since then, some studies have proposed alternative models, but none of them include all the variables of Clarke's model. Usually, they examine specific safety climate relationships with: accidents (Ajslev et al., 2017; Aliabadi et al., 2020; Leitao & Greiner, 2016); injury rates with perceptions of supervisors as a mediator variable

(Lindgard et al. 2012); workers' behavior (Chen et al., 2021; Katz et al., 2019); safety performance (Barbaranelli et al., 2015; Zohar and Luria, 2005); workers' outcomes (e.g. physical abuse, emotional abuse, depression, job satisfaction, life satisfaction, back pain, and self-reported health) and productivity in manufacturing companies (Katz et al., 2019).
In this study, we want to check if safety climate affects the workers' health and if this effect is mediated by job satisfaction variables (see Fig.1). In doing so, we have considered most of the variables highlighted in the literature to construct a mediation model. Moreover, we fit our model with a single data source in contrast to the meta-analysis used in Clarke (2010).

*Safety climate*

As we have seen before, safety climate captures the workers' perceptions regarding safety in their company (Bergheim et al., 2015; Zohar, 2014) including several factors that can affect the performance of workers' tasks. In the existing literature, there are two different approaches to safety climate. On the one hand, there is a tendency to specialize the study in the industry and the company to capture its reality (Andersen et al., 2018; Choudhry et al., 2009). On the other hand, there is an intention to standardize it in order to create a basic model that can be used in different companies and sectors (Barbaranelli et al., 2015; Griffin and Neal, 2000; Luo, 2020).
Safety climate is a multidimensional concept (Zohar, 2000, 2014), so it is necessary to capture in it several factors of different nature. Many attempts have been made to find a model to develop a construct for safety climate, and many factors included in these studies are similar (Luo, 2021). Moreover, several studies propose a specific model to construct safety climate for the construction sector (Choudhry et al., 2009; Han et al., 2021; Kim et al., 2021; Schwatka et al., 2016). There is no single established model to measure safety climate (Han et al., 2021). Bamel et al. (2020) stated that it is necessary to continue researching safety climate and its specific factors.

Regarding the methodology to deal with multidimensional constructs, a second-order factor model is a useful approach (Chen et al., 2005). The higher-order factor is composed of the first-order factors, which are the sub-dimensions that made up the multidimensional construct (Hair et al., 2006). A second-order factor reduces the number of variables that need to be estimated in a structural model without losing measurement accuracy (Koufteros et al., 2009). The higher-order factor model provides a more parsimonious and interpretable model than a first-order factor model and therefore, has considerable potential for advancing research on a multidimensional construct (Nunkoo et al., 2017).
To address the concept of safety climate broadly, we have first checked the most salient factors that researchers have included when they constructed safety climate (Table 1). Zohar (1980) presented eight factors to measure the safety climate according to the workers' perceptions on the importance of safety training, management attitudes to safety, effects of safe conduct on promotion, level of risk at the workplace, effects of required work pace on safety, the status of safety officer, the effect of safe conduct on social status, and status of the safety committee. The same author (Zohar, 2000) proposed a group-level model to measure safety climate, including management commitment, support, and safety communication items.
After reviewing the related literature, we propose six factors to develop the safety climate construct, five of which are the most salient factors identified in previous studies, adding one additional factor highlighted in a recent study.
As a first dimension of the concept, to achieve a good safety climate, there is a consensus on the need for the collaboration of all those involved in the building process, from management and supervisors to workers. Thus, management commitment stands out as the first factor reflecting the needed responsibility of the management with the safety issues within the company (Ajslev et al., 2017; Chan et al., 2017; Choudhry et al., 2009; Fang et al., 2006; Kim et al., 2021; Lindgard et al., 2012; Mosly, 2019; Niu et al., 2021; Schwatka et al., 2016; Zhou et al., 2015). Managers can improve the safety climate by recognizing their employees when they have

done a good job, and by organizing and distributing their tasks fairly (Goldenhar, Williams, and Swanson, 2003).

No less important is the second factor, the necessary employee involvement (Ajslev et al., 2017; Chan et al., 2017; Choudhry et al., 2009; Fang et al., 2006; Kim et al., 2021; Lindgard et al., 2012; Mosly, 2019; Niu et al., 2021; Schwatka et al., 2016; Zhou et al., 2015). All participants in the process must do their part of the task to achieve improvements in the final workers' outcomes, like health. The safety climate will be different if the employees are involved in doing a good job, and doing it safely. A way of enhancing the workers' involvement is by empowering them. This can be done by facilitating interactions between colleagues and giving employees the autonomy to apply their ideas, to decide what they think is essential for accomplishing their job duties, or to control the necessary time to do it. Arocena et al. (2008) pointed out that this empowerment can contribute to reducing the number of injuries, and one can conclude that this higher empowerment affects safety climate by reinforcing the worker involvement.

The third factor is safety communication, which includes the necessary communication between all those who are involved in any operational process, giving the appropriate information, and the training to perform the jobs properly (Chan et al.,2017; Choudhry et al., 2009; Kim et al., 2021; Niu et al., 2021; Schwatka et al., 2016). According to safety laws and regulations across Europe, the employer must provide training to the workers, to provide the workers with the knowledge, skills, and abilities to analyze their tasks and make decisions to perform them in the best and safest way. To ensure a good job performance, good communication in general and safety communication in particular are required. This communication must be fluid and bidirectional (from top to bottom in the company's hierarchical structure and vice versa). There are empirical studies that found a positive effect of the working environment conditions on the accident results, which is moderated by the quality of safety communication, especially the effect was stronger when the communication came from an immediate superior position, such as foremen (Jeschke et al., 2019).

Regarding the effect of the work environment on safety climate during the performance of the work stands out the exposure to risks. Avoiding the workers' exposure to risk requires a prior risk assessment and human and material resources organization. Hence, the fourth factor of safety climate is risk appraisal and risk-taking. Furthermore, it is well-known that to perform a job safely the employee needs the support of the company managers. Only in this way, the work will be done with the required resources, ensuring the integration of safety into all company processes. Thus, manager support is the fifth factor of safety climate (Ajslev et al., 2017; Kim et al., 2021).

Up to this point, we have included the factors that are most frequently repeated in most of the studies reviewed. Just a few studies related to safety climate have integrated the workers' psychological capital (PsyCap), which is an index of positive work motivation (Bergheim et al., 2015). It is composed of four dimensions: first, efficacy -the conviction in own abilities to carry out the work-, second, optimism -confidence in current and future success-, third, hope - to pursue the objectives and, if necessary, reorient the path to achieve them-, and fourth - resiliency -ability to sustain and recover to achieve success when a problem arises- (Luthans, 2002; Stratman & Youssef-Morgan, 2019). Clarke (2010) stated that the psychological climate affected the safety climate and included this concept as an antecedent. Wang et al. (2018) noted that psychological capital positively influences safety compliance (safety regulations compliance) and participation (engagement and promotion of safety activities), and therefore, it is a factor to consider to improve safety climate. In addition, Bergheim et al. (2015) showed that PsyCap was positively related to and explained between 10 and 12% of the variance in workers' perceptions of safety climate in their study in the maritime industry. A recent systematic literature analysis of safety climate (Bamel et al., 2020) emphasized that there is a gap concerning implications of psychological capital perspective in safety climate. In our measurement model, psychological capital will be the sixth and last factor considered to explain safety climate. This supposes a contribution to the literature by being the first empirical study including psychological capital as a latent variable affecting safety climate specifically in the construction sector.

Appendix 1 reports the items forming each of the six factors composing safety climate.

Thus, regarding the safety climate construct, our first hypotheses are stated as follows:
H1a. Management commitment, employee involvement, safety communication, risk appraisal and risk-taking, management support, and psychological capital are distinct, but related sub-dimensions of safety climate and can be accounted for by a common underlying second-order safety climate factor model which is significantly better than a first-order safety climate factor model.
H1b. Including psychological capital as a new factor of a second-order safety climate factor model significantly improves the results of the model without considering this factor.

Table 1
Factors of safety climate.

| Safety climate factors | nº | Authors |
|---|---|---|
| Management commitment | 10 | Ajslev et al., 2017<br>Chan et al., 2017<br>Choudhry et al., 2009<br>Fang et al., 2006<br>Kim et al., 2021<br>Lindgard et al., 2012<br>Mosly, 2019<br>Niu et al., 2021<br>Schwatka et al., 2016<br>Zhou et al., 2015 |
| Employee involvement | 10 | Ajslev et al., 2017<br>Chan et al., 2017<br>Choudhry et al., 2009<br>Fang et al., 2006<br>Kim et al., 2021<br>Lindgard et al., 2012<br>Mosly, 2019.<br>Niu et al., 2021<br>Schwatka et al., 2016<br>Zhou et al., 2015 |
| Risk appraisal and risk-taking (behavior) | 7 | Chan et al., 2017<br>Fang et al., 2006<br>Kim et al., 2021<br>Niu et al., 2021<br>Schwatka et al., 2016<br>Wang et al., 2018<br>Zhou et al., 2015 |
| Safety communication | 5 | Chan et al.,2017<br>Choudhry et al., 2009<br>kim et al., 2021<br>Niu et al., 2021<br>Schwatka et al., 2016 |
| Management support | 2 | Ajslev et al., 2017<br>Kim et al., 2021 |

*Safety climate – workers' health relationship*

Several studies have shown that safety climate significantly influences safety outcomes, such as accidents (Ajslev, 2017; Aliabadi, 2021), which implies an immediate physical health damage that can lead to mental problems too, when the accident occurs or afterward. Furthermore, a better safety climate positive influences workers' behavior (Chen et al., 2021; Clarke, 2010), if it worsens, it can produce the opposite effect, thus affecting the workers' mental health. In this line, Katz et al. (2019) carried out an empirical analysis of three big manufacturing companies. They stated that perceived safety climate was positively associated with physical activity and fewer mental health problems, like sleeping problems or depression. Mental health is not usually included in construction field studies. That is why we aim to study the relationship between safety climate and construction workers' health by differentiating both types of health, physical and mental. Therefore, we state our second hypothesis as follows:

H2a. Safety climate has a direct positive and significant effect on workers' mental health.

H2b. Safety climate has a direct positive and significant effect on workers' physical health.

*Job satisfaction*

Some studies connect safety climate with safety outcomes through the mediator role of job satisfaction (Balogun et al., 2020; Clarke, 2010; Huang et al., 2016; Smith, 2018). Job satisfaction is a concept studied in several fields. It is hard to measure due to the lack of a common understanding of what job satisfaction refers to (Punzo et al., 2018). However, it is usually presented as a positive affective response to one's job (Locke, 1976; Clarke, 2010) or the workers' expectation about what some aspects of the work should be and what they actually are (Gomez-Baya & Lucia-Casademunt, 2017; Igalens & Roussel, 1999).

Following the criterion of most of the reviewed literature, we evaluate how certain factors affect overall job satisfaction. Most of them are extracted from the demand-control-support model (Karasek-Theorell, 1990) and the effort-reward imbalance model (Siegrist, 1996). These models are commonly used when researchers study job satisfaction (Punzo, 2018). They also posit that high work demand and low work control lead to adverse health outcomes (Phipps, 2012). Some of these studies studied the relationship between some specific characteristics of job satisfaction -such as working conditions- and mental health (Cottini & Lucifora, 2013) or physical health (Nappo, 2019). Also, recent approaches considered its effects on personal well-being (Bakhshi et al., 2008; Gomez-Baya & Lucia-Casademunt, 2017).

In this literature, we have found a set of four specific dimensions regarding individual work-related facets which are used to form the job satisfaction construct.

First, we have identified the workers' profiles, such as socio-demographic characteristics, e.g., gender, age, education, and work experience (Nappo, 2019; Punzo, 2018).

Second, we found job compensation and rewards (i.e., economic remunerations, prospects for career advancement, job security, management, and social support) as one of the main factors of job satisfaction (Locke & Latham, 1990).

Third, we have found that working conditions, such as contractual arrangements (e.g. working hours, regular timetable, pace of work, quantity, or difficulty of work, among others), can affect the workers' feelings about their job, especially if there is a difference between the reality and the expected conditions (Nappo, 2019; Punzo, 2018).

Fourth, we observed a last variable, job control and work-life balance defined as the ability to schedule their own duties and find an equilibrium between personal and professional activities. This work-life balance seems to be more and more relevant due to the current employees' and society's demands (Cottini & Lucifora, 2013; Gomez-Baya & Lucia-Casademunt, 2017; Punzo et al., 2018).

*Safety climate – Job satisfaction*

Based on the analyses of the related literature, we suggest that the perceptions of a better safety climate will make the employees realize that they are valued members of the organization, something that will be associated with high levels of job satisfaction. Therefore, by making the workers feel they are valuable participants in the company, it is reasonable to argue that job satisfaction is likely to influence an individual's motivation and behavior for

improving safety performance (Goldenhar, Williams, and Swanson, 2003; Punzo, 2018). This change of behavior can make a difference in making even extra efforts (Clarke, 2010).
There have been previous studies examining the relationship between safety climate and job satisfaction. For example, Balogun et al. (2020) tried to explain employee's turnover intention as a function of safety climate mediated by job satisfaction. Those authors found a significant and positive relationship between safety climate and job satisfaction. Hence, in the context of our model, we posit that safety climate will be positively related to job satisfaction, and therefore with its factors: working conditions, work-life balance, and job rewards and compensations. Consequently, we state our third hypothesis as follows:
H3. Safety climate has a positive and significant effect on some job satisfaction variables.

H3a. Safety climate has a positive and significant effect on working conditions.

H3b. Safety climate has a positive and significant effect on working life balance.

H3c. Safety climate has a positive and significant effect on job rewards and compensations.

<u>*Job satisfaction – workers' health*</u>

As we had already reviewed, at the same time, there is a direct relationship between job satisfaction and workers' health (Gomez-Baya & Lucia-Casademunt, 2018; Hünefeld et al., 2020; Roelen, 2008). In particular, there are other studies that have analyzed the relationships between some specific job satisfaction factors, such as working conditions, with mental or physical health (Cottini and Lucifora, 2013; Nappo, 2019). In most of these studies, the authors found a positive relationship between job satisfaction and employees' optimal behavior in terms of safety (Gomez-Baya & Lucia-Casademunt, 2018; Nielsen et al., 2017). In this way, human resource managers can meet workers' basic needs to keep them satisfied and enhance favorable workers' behaviors (Edgar & Geare, 2005; Gomez-Baya & Lucia-Casademunt, 2018) because satisfied workers are more involved in their own duties, and this change in attitudes may reduce their exposure to risks, thereby improving workers' health (Gomez-Baya & Lucia-Casademunt, 2018; Nielsen et al., 2017).

So, we state our following hypotheses regarding job satisfaction. More specifically, job satisfaction factors will be positively associated with mental and physical workers' health.
H4. Working conditions have a positive and significant effect on workers' health.

H4a. Working conditions have a positive and significant effect on workers' mental health.

H4b. Working conditions have a positive and significant effect on workers' physical health.

H5. Work-life balance has a positive and significant effect on workers' health.

H5a. Work-life balance has a positive and significant effect on workers' mental health.

H5b. Work-life balance has a positive and significant effect on workers' physical health.

H6. Job rewards and compensation have a positive and significant effect on workers' health.

H6a. Job rewards and compensation have a positive and significant effect on workers' mental health.

H6b. Job rewards and compensation have a positive and significant effect on workers' physical health.

Up to this point, based on previous studies, we have proposed a model to analyze whether safety climate is directly related to each of the three components of job satisfaction: working conditions, work-life balance, and job rewards and compensations (Hypothesis H3). Besides, we have proposed to check whether safety climate positively affects physical and mental health (Hypothesis 2). Additionally, we have proposed if working conditions, work-life balance, and job rewards and compensations may affect workers' health (Hypotheses H4-H5-H6).

*Mediation role of Job satisfaction*

According to Clarke (2010), companies with a higher level of safety climate can have their employees more satisfied as they can feel more valued by their companies. These workers will improve their attitudes if they are satisfied with their jobs (Huang et al., 2016). This change in behavior can lead to fewer health problems (Gomez-Baya & Lucia-Casademunt, 2018). Clarke (2010) stated the mediating role of job satisfaction in the relationship between safety climate and safety behavior in her model to explain occupational accidents. Gomez-Baya & Lucia-Casademunt (2018) analyzed the mediation role of job satisfaction in the relationship between workers' psychological needs and mental problems, considering the possibility of a total or partial mediation effect. Consequently, we want to check whether the relationship between safety climate and workers' health is mediated by job satisfaction decomposed into its three factors. In this regard, we explore the possibility of a total mediation (i.e., if safety climate affects workers' health only through their influence on the components of job satisfaction) or a partial mediation (i.e., if safety climate presents also a direct effect on workers' health).

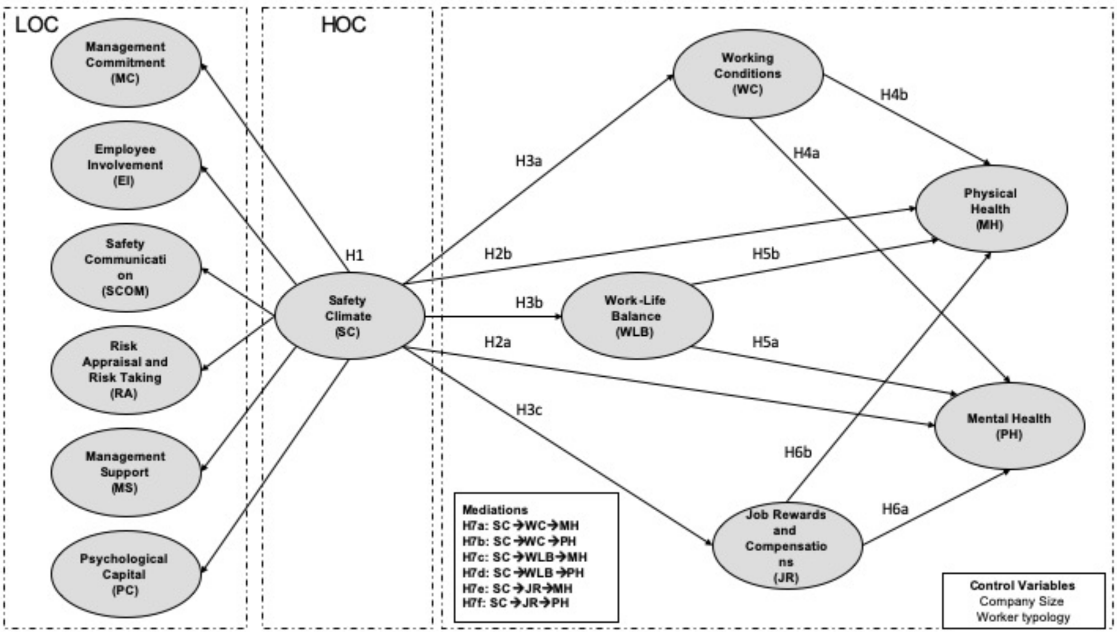
The statement of the mediation hypotheses is as follows:

H7. Safety climate significantly affects workers' health through its effect on job satisfaction variables.

- H7a. Safety climate significantly affects workers' mental health through working conditions.
- H7b. Safety climate significantly affects workers' physical health through working conditions.
- H7c. Safety climate significantly affects workers' mental health through work-life balance.
- H7d. Safety climate significantly affects workers' physical health through work-life balance.
- H7e. Safety climate significantly affects workers' mental health through job rewards and compensations.
- H7f. Safety climate significantly affects workers' physical health through job rewards and compensations.

Figure 1

Theoretical model




Note: LOC – Low Order Constructs; HOC – High Order Construct

Considering all the hypotheses indicated above, our complete model can be seen in figure 1.

## 5.3. METHODOLOGY, SAMPLE, AND DATA.

### 5.3.1. Sample and data.

We have used the secondary data from the latest wave of the European Working Conditions Survey (6th EWCS, 2015) in our empirical analyses to investigate the links between safety climate and workers' health. The complete sample includes 35 countries, including the EU28, Norway, Switzerland, Albania, the former Yugoslav Republic of Macedonia, Montenegro, Serbia, and Turkey. The survey provides a detailed picture of the working conditions and attributes in Europe across countries, industries, occupations, genders, and age groups.

Eurofound provides an exhaustive description of the survey design and data, and all this information is available from the website of the UK data service. Approximately 43,000 randomly selected workers were interviewed face-to-face. The questionnaire includes 106 questions covering a wide range of issues related to employment status, work organization, training, physical and psychosocial hazards exposures, health and safety, job demands, work organization practices, work-life balance, worker participation in company's decisions, type of contract, earnings and financial security. In Spain, 3,361 completed interviews were carried out, of which 499 were workers from the construction and transport sector, 628 workers from agriculture and industry, 789 workers from trade, accommodation, and food services, 778 workers from non-public services, and 667 workers from public services. The data were collected by using the EWCS survey in Spain through a questionnaire from February through October 2015.

As we have introduced, we focus our study on the construction sector in Spain. Thus, our sample of workers was composed by all random observations contained in the EWCS of all workers in the Spanish construction sector, which was a total of 232 workers. Since the total population of Spanish construction workers was 1.058.500 (INE, 2015), the sample error of our final sample was 6.43 % with 95% of statistical confidence (Del Castillo, 2008).

The demographics of the sample are presented in Table 2. The average age of our sample of 232 workers was 42 years (s.d. = 10.30; min 17, max 63), of whom 214 were men (92.24%) and 18 were women (7.76%). Of the total number of workers, 186 (80.17%) were workers without people under their supervision, and 46 were workers with at least one employee under their supervision, on whom pay increases, bonuses, or promotions depend directly.

Regarding the size of the companies, 38 of the respondents were self-employed, 102 worked in micro-companies (with up to 9 workers), 60 worked in small or medium companies (between 10 and 249 workers), 17 worked in large companies (more than 250 workers), and 15 respondents did not answer this question.

Table 2
Socio-demographic characteristics of the sample

| Demographic characteristics | Demographic levels | n | % | cum |
|---|---|---|---|---|
| Gender | Man | 214 | 92.24 | 92.24 |
| | Woman | 18 | 7.76 | 100 |
| | | | | |
| Level of education | Primary education | 39 | 16.81 | 16.81 |
| | Secondary education | 163 | 70.26 | 87.07 |
| | Postsecondary (tertiary) education | 22 | 9.49 | 96.55 |
| | Postsecondary (tertiary) education, 2º cycle (Master) | 5 | 2.16 | 98.71 |
| | Postsecondary (tertiary) education, 2º cycle (Doctorate) | 1 | 0.43 | 99.14 |
| | Do not Know | 1 | 0.43 | 99.57 |

| | | | | |
|---|---|---|---|---|
| | Refusal | 1 | 0.43 | 100 |
| | | | | |
| Current situation | At work as an employee | 176 | 75.86 | 75.86 |
| | Self-employed | 53 | 22.84 | 98.71 |
| | Do not Know | 1 | 0.43 | 99.14 |
| | Refusal | 2 | 0.86 | 100 |
| | | | | |
| Type of contract | Part-time | 29 | 12.66 | 12.66 |
| | Full time | 200 | 87.34 | 100 |
| | | | | |
| Sector | Private sector | 216 | 93.10 | 93.10 |
| | Public sector | 9 | 3.88 | 96.98 |
| | A joint private-public organization or company | 3 | 1.29 | 98.28 |
| | Other | 3 | 1.29 | 99.57 |
| | NC | 1 | 0.43 | 100 |
| | | | | |
| Job position | With people under my supervision | 44 | 18.98 | 18.98 |
| | Without people under my supervision | 186 | 80.17 | 99.15 |
| | Do not know | 1 | 0.43 | 99.57 |
| | Refusal | 1 | 0.43 | 100 |
| | | | | |
| Seniority | Less than 1 year | 54 | 23.28 | 23.28 |
| | From 1 to 5 years | 67 | 28.87 | 52.15 |
| | From 6 to 10 years | 37 | 15.52 | 67.67 |
| | From 11 to 15 years | 33 | 14.22 | 81.89 |
| | More than 16 years | 33 | 14.66 | 96.55 |
| | Do not know | 5 | 2.16 | 98.71 |
| | Refusal | 3 | 1.29 | 100 |

Descriptive analyses were performed using STATA, and the model analysis was carried out using SmartPLS v.3 software (Ringle, Wende, & Becker, 2015). Partial least squares structural equation modelling (PLS-SEM) was used to assess the quality of the measurement instrument and the hypotheses of the proposed model. PLS-SEM is a particularly appropriate method when small samples are used and when the normality of the data is not assumed (Hair et al., 2012). In the present study, it was impossible to ensure that the data obtained were normally distributed using the Shapiro-Wilk normality test and the Kolmogorov-Smirnov test. Therefore, it was appropriate to use the SmartPLS3 software (Ringle et al., 2015). The stability of the estimates was confirmed by bootstrapping (5000 subsamples), with two-tailed tests, and at a significance level of 0.05.

### 5.3.2. Variables

**Dependent variables**

The main dependent variables in our proposed theoretical model are mental and physical health. Both are subjective indicators of health that were collected through individual responses in the survey (all the items included in these variables can be seen in the Appendix 1). We posit that safety climate is directly related to workers' health and mediated by working conditions, work-life balance, and job rewards and compensations, which are the three variables capturing job satisfaction.

Regarding mental health and physical health latent variables, formative factors were considered. That is, the indicators and the construct have inverted causal relationships assuming that the observed indicators cause the latent variable, and they cannot be replaced or exchanged (Hair et al., 2014).

Mental health refers to emotional and psychological well-being. In the literature, we found some indicators for general and specific mental health trying to capture whether or not the work can cause employees' mental problems such as stress, fatigue, sleeping problems, anxiety, and irritability (Cottini & Lucifora, 2013). From EWCS we have included all these indicators of mental problems measured on a 5-point Likert-type scale from one (very good), two (good), three (acceptable), four (bad), to five (very bad).

In the reviewed literature, physical health refers to physical injuries or problems such as skin problems, backache, and muscular pains in the upper or lower limbs. All the responses in the EWCS related to this type of health problems were expressed with 'yes' or 'no'.

**Explanatory variables**

The explanatory latent variables in the model are safety climate, working conditions, work-life balance, and job rewards and compensations. These variables were considered as reflective latent variables, which means that the observed indicators are caused by the latent unobserved variable. All the indicators and the construct can also be seen in Appendix 1.

*Safety climate*

As we mentioned in the previous section, to construct our safety climate variable, we have considered six latent variables: management commitment, employee involvement, safety communication, risk appraisal and risk-taking, management support, and psychological capital. We have used different items to construct each variable, all the items were extracted from the EWCS, and were directly focused on safety or they were aspects that affected the safety management and performance, such as the commitment of the manager in making people working together or the worker's involvement in improving the work or process. For construct *management commitment*, three items of the EWCS survey were used, including the extent to which the work is distributed fairly, the trust of the manager in their workers to do their work well, and the employees' perception that they are appreciated when they have done a good job. For *employee involvement*, five items were used, including if they are involved in improving work organization or processes, or manage their work time, if they apply their own ideas into the work, and if they can influence critical decisions to their work. For *safety communication*, three items were used including if the company gives useful feedback on the work, if they can resolve the conflicts in a fair way, and communication/cooperation between colleagues. For risk appraisal and risk-taking, six items were included the items of the EWCS that refers to risk expositions as vibrations, noise, extreme temperatures, tiring o painful positions, move heavy loads. For *management support*, five items were used, including if the workers feel respected by their boss, if the boss encourages and supports them, if the boss gives them praise and recognition, if they help in getting people to work together, and if they are helpful in getting the job done. To construct *psychological capital*, five items were used, including the workers' feelings when they are at work to capture if they have hope to succeed, resiliency if they found a problem, optimism, and efficacy: interest, cheerfulness, calmness, activity, and restfulness. All the items for all latent variables were measured or re-coded on a 5-point Likert-type scale.

In many of the reviewed studies, the factors included to measure safety climate were similar, but they were measured in different ways, and often the detail of the measurement is missed. In this study, we report precisely how each of the factors is measured by specifying all items and measures (see Appendix 1). Therefore, one of the contributions of this study is to establish an accessible measurement model that can be replicated and to make the results comparable in different studies on countries, sectors, etc.

*Job satisfaction: working conditions, work-life balance, job rewards and compensation*

Regarding job satisfaction, in most of the reviewed studies, it was measured by asking the workers directly how satisfied they were with their job (Hünefeld et al., 2020) or how satisfied they were with the working conditions in their job (Hünefeld et al., 2020; Nappo, 2019), or both questions (Wagenaar et al., 2012).

Punzo et al. (2018) captured the construct of job satisfaction through a set of variables including individual characteristics (age, gender, education, seniority, activity details, type of contract, company size, etc.), working conditions, job rewards and monetary compensations, and work-life balance. In this study, we followed this idea to capture the effect of the different factors of job satisfaction on workers' health. Specifically, we have considered the three last variables as endogenous, using the individual characteristics variable as a control.

First, *working conditions,* which contains hours worked per week, work pace, and disturbing situations at work. Second, *work-life balance*, which reflects the equilibrium between personal and work life, which is not usually included in studies focused on the construction sector but is well identified by other sectors (Allen et al., 2000; Punzo et al., 2018). The third and last latent variable is *job rewards and compensation* that includes respondents' perceptions about manager recognition and support, colleagues' recognition, prospect for career advancement, and the equity of labor incomes.

In our model, each respondents' question and, consequently, all items used to measure any explanatory variable were measured on 5-point Likert-type scales from 1, the most positive, to 5, the most negative response. In doing so, some questions were removed from the model, and others were re-coded to change the sense of the answers to follow the same criterion in all the items included in the model.

## 5.4. RESULTS

**Common Method Bias**

The data were collected from the same source through an identical collection method, so common method bias (CMB) may be a potential problem (Podsakoff et al., 2003). First, a confirmatory factor analysis (CFA) Harman's single-factor model test was conducted and followed by an unmeasured latent variable test (Markel & Frone, 1998). If a single item has a total variance greater than 50% it can introduce CMB into the data and empirical conclusions (Podsakoff et al., 2003). In the study, the total variance of a single factor was 21.95%, and the evaluation of all factors introduced in the model leads to 42.74% explained variance. This suggests that CMB should not be a problem for this data set (Molinillo et al., 2021).

**Evaluation of the measurement model**

Table 3 shows the results of construct reliability and convergent validity assessments.

Following we present the items that were removed from the factors due to their factor loadings did not exceed the value of 0.7: In the model to construct safety climate we have removed items from three different factors: management commitment, employee involvement, and risk appraisal and risk taking. Specifically, from the management and organizational commitment factor the item MC21 -if the company has provided training to the workers- was removed. From the employee involvement factor, the items EI21 -help and support between colleagues, and EI22 -trust of employees in the manager- were removed. From the risk appraisal and risk-taking factor, five items related to risk exposition were removed (RA17/18/19/20/21). From the job rewards and compensations factor one item were removed (JR21), it was related to the possibility to lose the job in the next six months.

In addition, some items were excluded from the model because they cannot be re-coded in a 5-Likert scale response. In the model to construct safety climate variable we have removed items from two factors. Specifically, from the management and organizational commitment factor were removed five items (MC21/22/23/24/25) related to -if the company has provided training and personal protective equipment to the workers, if there is a committee representing employees in the company, or a health or safety committee, or if there are regular meetings in which employees can express their views -. From the employee involvement factor, two items were removed (EI23/22) related to if -employees trust management and if the workers use personal equipment when necessary-. Regarding the full model connecting safety climate to workers health, we have removed some items from different factors. As regards of job satisfaction, we have not considered the job satisfaction as a factor, although we have the item that directly asks for general job satisfaction. This item was removed (JB21), because is difficult to determine the reliability of a single-item measure (Roeden, 2008). Following the structure of other studies focusing on job satisfaction (Punzo, et al. 2018), we consider it a reflective latent variable, and we have included the factors that better can reflect job satisfaction. Thus, we have included working conditions, work-life balance, and job rewards and compensations. In contrast to Punzo et al's (2018) study, we have not included directly the items related to individual characteristics such as gender, age, and human capital (seniority, level of education) due to their answers were not measured on a 5-Likert scale. We propose to use them in our model as control variables, to assess if there are differences in the model at the measurement and structural level. From the three factors that reflect job satisfaction in our model, we have removed items from two factors. From the working conditions factor, we have removed four items related to working hours, the pace of work, quantity, and difficulty of work (WC21,22,23,24), because all of them were coded as numerical or dichotomous instead of a 5-point Likert scale.

All the latent variables of the theoretical model to be tested were reflective, except for the case of the endogenous latent variables (mental health and physical health). To unequivocally verify this statement, a theoretical analysis was carried out on the meaning of such relationships between the indicators and the endogenous latent construct of the study. Also, a quantitative analysis based on the confirmatory tetrad analysis in PLS (CTA-PLS) (Hair et al., 2018) was carried out (Hair et al., 2018). Finally, it was found that the mental health (MH) and physical health (PH) variables were formative.
Both Cronbach's alpha (CA) and the composite reliability (CR) of the different latent variables exceeded in all cases the minimum value of 0.8 suggested by Nunnally (1978). In addition, to assess the collinearity of the inner model, Variance Inflation Factor (VIF) was used, obtaining values lower than 5 in all cases, so there was no collinearity problem (Hair et al., 2011). As for the analysis of average variance extracted (AVE), the minimum recommended level of 0.5 was exceeded for all the latent constructs incorporated into the theoretical model (Fornell and Larcker, 1981).
Three valid PLS-SEM methods were followed to test discriminant validity: i) loading coefficients should be greater than the cross-loadings; ii) inter-construct correlations should be less than the square root of the AVEs (Table 4); iii) the heterotrait-monotrait ratio (HTMT) should be less than 1 (Table 4).
Finally, concerning the evaluation of the measurement model, all values were found to be below the maximum recommended thresholds. Therefore, the results supported the consideration of the reliability and validity of the measures used. Thus, it could be affirmed that the structural model is suitable for analysis.

Table 3
Variable descriptive statistics, reliability, and convergent validity

| Constructs | Items | M | SD | Weight | Loading | VIF | CA | rho_A | CR | AVE |
|---|---|---|---|---|---|---|---|---|---|---|
| Management Commitment (MC) | | | | | | | 0,852 | 0,853 | 0,910 | 0,771 |
| | MC11 | 1.815 | 1.093 | 0.361*** | **0.862*** ** | | | | | |
| | MC12 | 2.034 | 1.178 | 0.387*** | **0.895*** ** | | | | | |
| | MC13 | 2.082 | 1.231 | 0.390*** | **0.878*** ** | | | | | |
| Employee Involvement (EE) | | | | | | | 0.817 | 0.819 | 0.872 | 0.577 |
| | EE11 | 2.487 | 1.793 | 0.265*** | **0.714*** ** | | | | | |
| | EE12 | 2.216 | 1.341 | 0.268*** | **0.776*** ** | | | | | |
| | EE13 | 2.560 | 1.513 | 0.197*** | **0.782*** ** | | | | | |
| | EE14 | 2.608 | 1.401 | 0.297*** | **0.813*** ** | | | | | |
| | EE15 | 2.108 | 1.362 | 0.293*** | **0.706*** ** | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Safety Communications (SC) | | | | | | | 0.554 | 0.572 | 0.767 | 0.528 |
| | SCOM11 | 2.200 | 1.466 | 0.543$^{***}$ | **0.728$^{***}$** | | | | | |
| | SCOM12 | 2.265 | 1.770 | 0.482$^{***}$ | **0.836$^{***}$** | | | | | |
| | SCOM13 | 1.956 | 1.707 | 0.339$^{***}$ | **0.596$^{***}$** | | | | | |
| Risk Appraisal and Risk-Taking (RA) | | | | | | | 0.860 | 0.876 | 0.895 | 0.587 |
| | RA11 | 3.086 | 1.764 | 0.168$^{***}$ | **0.722$^{***}$** | | | | | |
| | RA12 | 2.737 | 0.644 | 0.238$^{***}$ | **0.819$^{***}$** | | | | | |
| | RA13 | 2.944 | 1.600 | 0.192$^{***}$ | **0.773$^{***}$** | | | | | |
| | RA14 | 2.483 | 1.567 | 0.205$^{***}$ | **0.708$^{***}$** | | | | | |
| | RA15 | 3.263 | 1.721 | 0.297$^{***}$ | **0.761$^{***}$** | | | | | |
| | RA16 | 3.147 | 1.680 | 0.205$^{***}$ | **0.806$^{***}$** | | | | | |
| Management Support (MS) | | | | | | | 0.890 | 0.895 | 0.919 | 0.695 |
| | MS11 | 1.541 | 1.041 | 0.228$^{***}$ | **0.800$^{***}$** | | | | | |
| | MS12 | 2.400 | 1.477 | 0.214$^{***}$ | **0.776$^{***}$** | | | | | |
| | MS13 | 2.188 | 1.659 | 0.235$^{***}$ | **0.836$^{***}$** | | | | | |
| | MS14 | 1.924 | 1.260 | 0.265$^{***}$ | **0.873$^{***}$** | | | | | |
| | MS15 | 2.159 | 1.461 | 0.255$^{***}$ | **0.880$^{***}$** | | | | | |
| Psychological Capital (PC) | | | | | | | 0.862 | 0.865 | 0.901 | 0.646 |
| | PC11 | 2.013 | 0.848 | 0.248$^{***}$ | **0.812$^{***}$** | | | | | |
| | PC12 | 2.125 | 0.932 | 0.258$^{***}$ | **0.844$^{***}$** | | | | | |
| | PC13 | 2.060 | 0.931 | 0.258$^{***}$ | **0.852$^{***}$** | | | | | |
| | PC14 | 2.228 | 0.985 | 0.212$^{***}$ | **0.772$^{***}$** | | | | | |
| | PC15 | 2.022 | 0.971 | 0.270$^{***}$ | **0.731$^{***}$** | | | | | |
| Working Conditions (WC) | | | | | | | 0.632 | 0.656 | 0.843 | 0.729 |
| | WC11 | 1.642 | 1.244 | 0.652$^{***}$ | **0.890$^{***}$** | | | | | |
| | WC12 | 2.043 | 1.420 | 0.515$^{***}$ | **0.816$^{***}$** | | | | | |
| Work-Life Balance (WLB) | | | | | | | 0.577 | 0.724 | 0.760 | 0.521 |
| | WLB11 | 2.677 | 1.397 | 0.317$^{***}$ | **0.601$^{***}$** | | | | | |
| | WLB12 | 2.478 | 1.511 | 0.308$^{***}$ | **0.650$^{***}$** | | | | | |
| | WLB13 | 2.030 | 1.582 | 0.690$^{***}$ | **0.883$^{***}$** | | | | | |
| Job Rewards and Compensations (JRC) | | | | | | | 0.551 | 0.614 | 0.810 | 0.683 |
| | JR11 | 3.009 | 1.613 | 0.720$^{***}$ | **0.899$^{***}$** | | | | | |
| | JR12 | 3.573 | 1.931 | 0.472$^{***}$ | **0.746$^{***}$** | | | | | |
| Mental Health (MH) (Composite model. Mode B) | | | | | | | | | | |
| | MH11 | 1.815 | 1.093 | **0.111$^{***}$** | 0.393$^{***}$ | 2.376 | | | | |
| | MH12 | 2.034 | 1.178 | **0.025$^{***}$** | 0.350$^{***}$ | 2.441 | | | | |
| | MH13 | 2.082 | 1.231 | **0.038$^{***}$** | 0.454$^{***}$ | 2.106 | | | | |
| | MH14 | 3.112 | 1.328 | **-0.899$^{***}$** | -0.969$^{***}$ | 1.137 | | | | |
| | MH15 | 3.004 | 1.547 | **0.178$^{***}$** | 0.334$^{***}$ | 1.063 | | | | |
| Physical Health (PH) (Composite model. Mode B) | | | | | | | | | | |
| | PH11 | 1.431 | 0.495 | **0.138$^{***}$** | 0.705$^{***}$ | 1.939 | | | | |
| | PH12 | 1.461 | 0.498 | **0.621$^{***}$** | 0.861$^{***}$ | 2.527 | | | | |
| | PH13 | 1.388 | 0.487 | **0.118$^{***}$** | 0.670$^{***}$ | 1.886 | | | | |
| | PH14 | 1.073 | 0.261 | **-0.222** | 0.011 | 1.101 | | | | |
| | PH15 | 1.043 | 0.203 | **0.168** | 0.311$^{*}$ | 1.041 | | | | |
| | PH16 | 1.323 | 0.468 | **0.287$^{***}$** | 0.601$^{***}$ | 1.198 | | | | |
| | PH17 | 1.056 | 0.230 | **0.200$^{***}$** | 0.328$^{***}$ | 1.096 | | | | |

Note. M = Mean; SD = Standard deviation; VIF = Variance Inflation Factor; CA = Cronbach's alpha; CR = Composite reliability; AVE = Average variance extracted; *p < 0.05, **p < 0.01, ***p < 0.001, one-tailed test; n = 5000 subsamples.
* 95% confidence level – two tailed.

Table 4
Discriminant validity

| | (EI) | (JR) | (MC) | (MS) | (PC) | (RA) | (SC) | (SCOM) | (WC) | (WLB) |
|---|---|---|---|---|---|---|---|---|---|---|
| EMPLOYEE INVOLVEMENT (EI) | ***0.760*** | 0.363 | 0.315 | 0.364 | 0.267 | 0.223 | 0.716 | 0.397 | 0.214 | 0.213 |
| JOB REWARDS AND COMPENSATIONS (JR) | 0.261 | ***0.826*** | 0.653 | 0.406 | 0.401 | 0.292 | 0.644 | 0.614 | 0.420 | 0.268 |
| MANAGEMENT COMMITMENT (MC) | 0.273 | 0.454 | ***0.878*** | 0.562 | 0.478 | 0.108 | 0.784 | 0.986 | 0.226 | 0.251 |
| MANAGEMENT SUPPORT (MS) | 0.317 | 0.292 | 0.490 | ***0.834*** | 0.327 | 0.165 | 0.809 | 0.978 | 0.157 | 0.250 |
| PSYCHOLOGICAL CAPITAL (PC) | 0.231 | 0.299 | 0.414 | 0.293 | ***0.804*** | 0.147 | 0.723 | 0.486 | 0.276 | 0.446 |
| RISK APPRAISAL AND RISK-TAKING (RA) | 0.199 | 0.217 | 0.087 | 0.148 | 0.128 | ***0.766*** | 0.606 | 0.163 | 0.419 | 0.417 |
| SAFETY CLIMATE (SC) | 0.561 | 0.471 | 0.741 | 0.790 | 0.654 | 0.388 | ***0.509*** | 0.959 | 0.409 | 0.493 |
| SAFETY COMMUNICATION (SCOM) | 0.269 | 0.330 | 0.642 | 0.685 | 0.324 | 0.112 | 0.720 | ***0.822*** | 0.193 | 0.319 |
| WORKING CONDITIONS | 0.168 | 0.231 | 0.165 | 0.120 | 0.202 | 0.316 | 0.279 | 0.112 | ***0.854*** | 0.358 |
| WORK-LIFE BALANCE (WLB) | 0.101 | 0.180 | 0.180 | 0.200 | 0.321 | 0.364 | 0.349 | 0.183 | 0.228 | ***0.722*** |

Note. The square roots of the AVEs are in italics and bold on the main diagonal. The Fornell-Larcker criterion is depicted below the main diagonal. The heterotrait-monotrait (HTMT) ratio is above the main diagonal.

## Models Comparison

Many studies suggested that safety climate is a multidimensional concept and comprises specific dimensions that are correlated, so it is convenient to consider the construct as a second-order factor (Chen et al., 2005).

Regarding hypothesis 1a, the six distinct but related subdimensions of safety climate can be explained by a common underlying higher-order factor model of safety climate that is significantly better than a first-order factor model.
Therefore, once the reliability and validity of the first-order factor measures were established, the performance of the second-order factor model of safety climate was evaluated. In accordance with the recommended procedures for testing second-order factor models (Rindskopf and Rose, 1988), we followed a hierarchical approach in which five models were developed.

Table 5
Model comparison

| Fit Indices | Single first order factor (M1) | Single first-order factor (M2) including psychological Capital | Correlated first-order factors (M3) | Correlated first-order factors + adding Psychological Capital (M4) | Six Correlated first-order factors, one second-order factor (M5) |
|---|---|---|---|---|---|
| $\chi^2$ | 1327.20 | 1895.64 | 499.50 | 671.78 | 589.22 |
| CFI | 0.52 | 0.46 | 0.87 | 0.88 | 0.90 |
| TLI | 0.46 | 0.42 | 0.85 | 0.86 | 0.89 |
| RMSEA | 0.15 | 0.14 | 0.08 | 0.07 | 0.06 |
| SRMR | 0.20 | 0.17 | 0.09 | 0.08 | 0.08 |
| $\chi^2$/df | 6.35 | 5.85 | 2.51 | 2.17 | 2.01 |

Notes: CFI – Comparative Fit Index; TLI – Tucker Lewis Index; IFI – Incremental Fit Index; RMSEA – Root Mean Square Error of Approximation; SRMR – Standardized Root Mean Square Residual

The M1 model consisted of a first-order factor model that considers the five factors of safety climate are separate and uncorrelated, this model does not include psychological capital as a new factor (Fig.2a). The M2 model replicated model 1 but included psychological capital as a new factor (Fig. 2b). In both cases, the fit indices were under the minimum acceptable values (Table 5). Then, the third model (M3 model) was analyzed with five correlated safety climate dimensions, without considering psychological capital, and without the existence of any second-order factor (Fig. 2c). The M4 model replicates the model M3, with the same five correlated safety climate sub-dimensions but including PC (Fig.2d). In the latter case, the obtained fit indices were above the acceptable values (CFI = 0.875; TLI = 0.859; RMSEA = 0.071; SRMR = 0.086; $\chi^2$/df = 2.174). Finally, the last model (M5) with Safety climate as a second-order factor was analyzed (Fig. 2e). It was composed of the six first-order factors (management commitment, employee involvement, safety communication, risk appraisal and risk-taking, management support, and psychological capital). The results of the fit indices were above the acceptable values, and they were slightly better than the previous model M4 (CFI = 0.902; TLI = 0.902; RMSEA = 0.066; SRMR = 0.087; $\chi^2$/df = 2.0109). Considering the results obtained, we retained the M5 model as the most appropriate and examined its performance in the global measurement model and in the structural model.

The full measurement model, which included the second-order factor model of safety climate, was further tested for reliability and validity. Reliability was assessed by analyzing the composite reliability and average variance extracted (AVE) values.

Figure 2a
Model 1. Five first-order uncorrelated factors

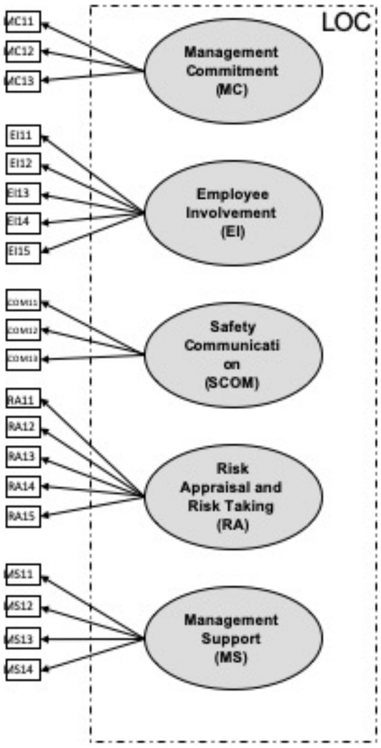



Figure 2b
Model 2. Six first-order uncorrelated factors

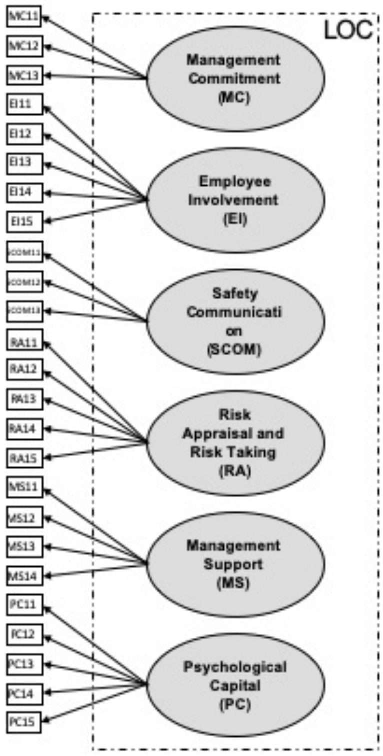



Figure 2c
Model 3. Five correlated first-order factors

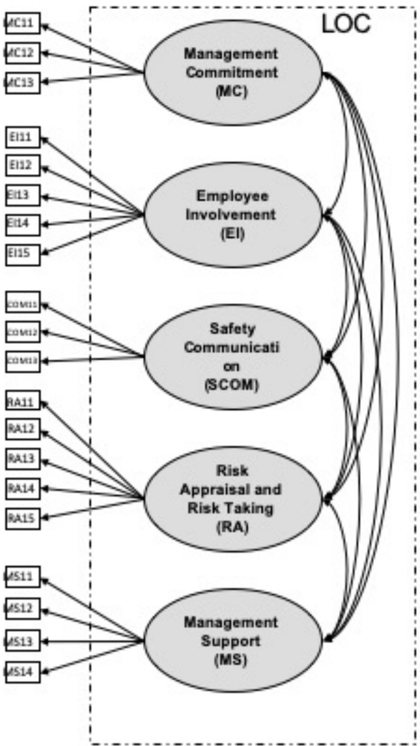



Figure 2d
Model 4. Six correlated first-order factors

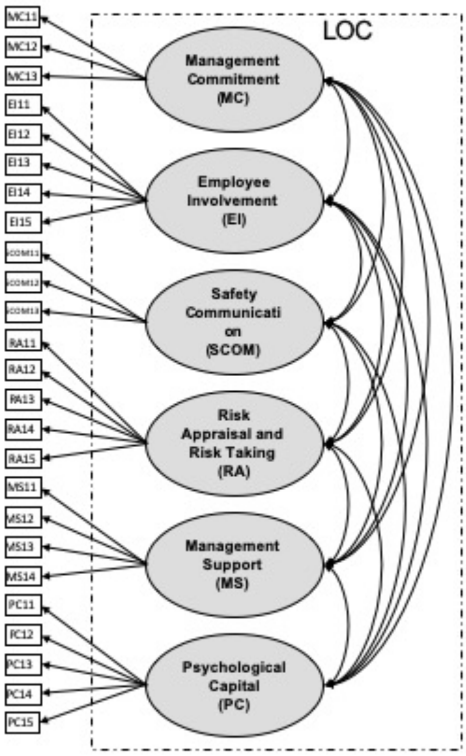
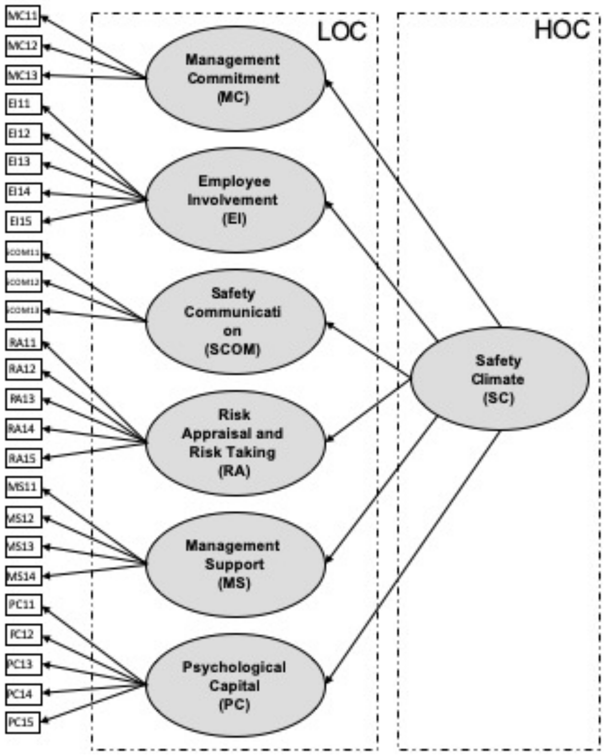


Figure 2e
Model 5. Six first-order factors, one second-order factor




**Power Analysis**
Prior to the structural model was analyzed, G*Power was used to determine whether the sample used met the minimum threshold required (Hair, et al., 2016). The power analysis was conducted using the heuristic rules of Cohen's power tables and the square root method (Cohen, 1988; Faul et al., 2009). The minimum required sample was 161 individuals, to obtain a power value of 0.99. Therefore, this result confirms that our sample, composed of 232 individuals, substantially exceeds the minimum required observations to be able to apply correctly the PLS-SEM method.

**Evaluation of the structural model**
With the evaluation of the structural model, the significance of the hypothesized relationships was analyzed, as well as the predictive relevance of the proposed model. First, a bootstrapping procedure was carried out with 5,000 subsamples to evaluate the significance of the coefficient paths (Hair et al., 2011). As shown in Table 6, most of the model hypotheses received empirical support in terms of direct effects, except H4a, H4b, and H6b.
The values of the predictive capacity of the model are also shown in Table 6. Specifically, the $R^2$ values for each variable exceed the minimum of 0.1 (Falk & Miller, 1992). The model explained a large part of the variance of the endogenous latent variables: mental health (76.5%) and physical health (22.8%). In addition, although to a lesser extent, the model also explained the latent constructs of job rewards and compensations (22.55%), work-life balance (12%), and working conditions (7.7%).
The predictive capacity of the dependent constructs and endogenous variables was also estimated using the $Q^2$ test and the blindfolding procedure (omission distance = 7) (Geisser, 1975; Stone, 1974). At all times, the results obtained were greater than 0, so the proposed model presented predictive relevance.

**Findings**

According to the literature that argued safety climate is a multidimensional construct, we hypothesized that the six factors of safety climate can be accounted for by a common underlying second-order safety climate factor model which is significantly better than a first-order safety climate factor model. Basing ourselves on the empirical results of models' comparison (Table 2), hypotheses 1a and 1b obtained sufficient empirical support. Furthermore, significant relationships ($p<0.001$) were found for each proposed factor to construct safety climate. The model estimation reveals that the high-order construct, Safety Climate, has a strong relationship with its low-order constructs. The strongest effect on safety climate was found in management commitment (MC) ($\beta 1a=0.778$ , $p<0.001$), followed by safety communication (SCOM) ($\beta 1c=0.775$, $p<0.001$), risk appraisal and risk-taking (RA) ($\beta 1d=0.773$, $p<0.001$), psychological capital (PC) ($\beta 1f=0.655$, $p<0.001$) has the fourth biggest effect in explaining safety climate, above employee involvement (EI) ($\beta 1b= 0.546$, $p<0.001$), and finally management support (MS) ($\beta 1e=0.363$, $p<0.001$).

Regarding the second hypothesis, which states the positive and direct effect of safety climate on mental and physical workers' health, the results showed strong and significant support. Safety climate was significantly correlated with mental health variables (H2a) and physical health (H2b). So, the higher the level of safety climate the better the workers' health.

Furthermore, the results allow us to conclude that safety climate has a strong effect on job rewards and compensations ($\beta 3c = 0.474$, $p < 0.001$), followed by work-life balance ($\beta 3b = 0.347$ $p < 0.001$) and working conditions ($\beta 3a = 0.278$, $p < 0.001$), thus, consistent with our third hypothesis.

In terms of direct effects, the mental health construct is mainly explained by the variables work-life balance ($\beta 5a = 0.813$, $p < 0.001$), job rewards and compensations ($\beta 6a = 0.165$, $p < 0.001$) and safety climate ($\beta 2a = 0.163$, $p < 0.001$). While the physical health variable is explained by the variables work-life balance ($\beta 5b = 0.287$, $p < 0.001$) and safety climate ($\beta 2b = 0.177$, $p < 0.05$). So, we can state that our fifth hypotheses (5a – Work-life balance effect on mental health, and 5b work-life balance effect on physical health) were supported.

Hypotheses 4 proposed that working conditions affected mental health (4a) and physical health (4b). These relationships were not supported as we obtained non-significant coefficients ($p>0.05$). This result is unexpected because the majority of the considered literature confirmed this relationship (Gomez-Baya & Lucia-Casademunt, 2018; Nappo, 2019). Different explanations for these results will be discussed in the next section.

Regarding H6, which stated the direct effect of job rewards and compensations on mental health (H6a) and physical health (H6b), we found support for H6b, that is, job rewards and compensations have a positive and significant effect on physical health ($\beta 6b = 0.165$, $p < 0.001$). Contrary to what we expected according to our hypothesis, we have not found significant support for the relationship between job rewards and compensations and mental health. The coefficient was negative but not significant ($\beta 6a = -0.050$, $p > 0.05$).

(see Table 6)

Table 6
Structural model evaluation

| Hypothesis | Constructs | $R^2$ | $Q^2$ | Effect size – $f^2$ | ß path (t – values) | [2,5% | 97,5% ] | Correlations | Supported |
|---|---|---|---|---|---|---|---|---|---|
| | ***Safety Climate (SC)*** | --- | | | | | | | |
| H2a | Mental Health | | | 0.077 | 0.163 (2.789) $^{***}$ | 0.059 | 0.285 | 0.424 | *Yes* |
| H2b | Physical Health | | | 0.028 | 0.177 (8.939) $^{*}$ | -0.036 | 0.361 | 0.361 | *Yes* |
| H3a | Working Conditions | | | 0.084 | 0.278 (3.834) $^{***}$ | 0.135 | 0.419 | 0.278 | *Yes* |
| H3b | Work Life Balance | | | 0.137 | 0.347 (1.711) $^{***}$ | 0.217 | 0.464 | 0.347 | *Yes* |
| H3c | Job Rewards and Compensations | | | 0.290 | 0.474 (8.939) $^{***}$ | 0.366 | 0.575 | 0.474 | *Yes* |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ***Working Conditions (WC)*** | 0.077 | 0.052 | | | | | | |
| H4a | Mental Health | | | 0.001 | 0.013 (0.368) (n.s.) | -0.056 | 0.082 | 0.232 | *No* |
| H4b | Physical Health | | | 0.001 | 0.023 (0.247) (n.s.) | -0.158 | 0.210 | 0.176 | *No* |
| | ***Work-Life Balance (WLB)*** | 0.120 | 0.056 | | | | | | |
| H5a | Mental Health | | | 2.418 | 0.813 (13.579) *** | 0.698 | 0.902 | 0.863 | *Yes* |
| H5b | Physical Health | | | 0.092 | 0.287 (3.651) *** | 0.131 | 0.433 | 0.383 | *Yes* |
| | ***Job Rewards and Compensations (JRC)*** | 0.225 | 0.143 | | | | | | |
| H6a | Mental Health | | | 0.008 | 0.165 (1.948) *** | -0.136 | 0.024 | 0.176 | *Yes* |
| H6b | Physical Health | | | 0.027 | -0.050 (1.210) (n.s.) | 0.015 | 0.346 | 0.306 | *No* |
| | ***Mental Health (MH)*** | 0.765 | | | | | | | |
| | ***Physical Health (PH)*** | 0.228 | | | | | | | |

Note: †p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001, one-tailed test.

## Mediation analysis

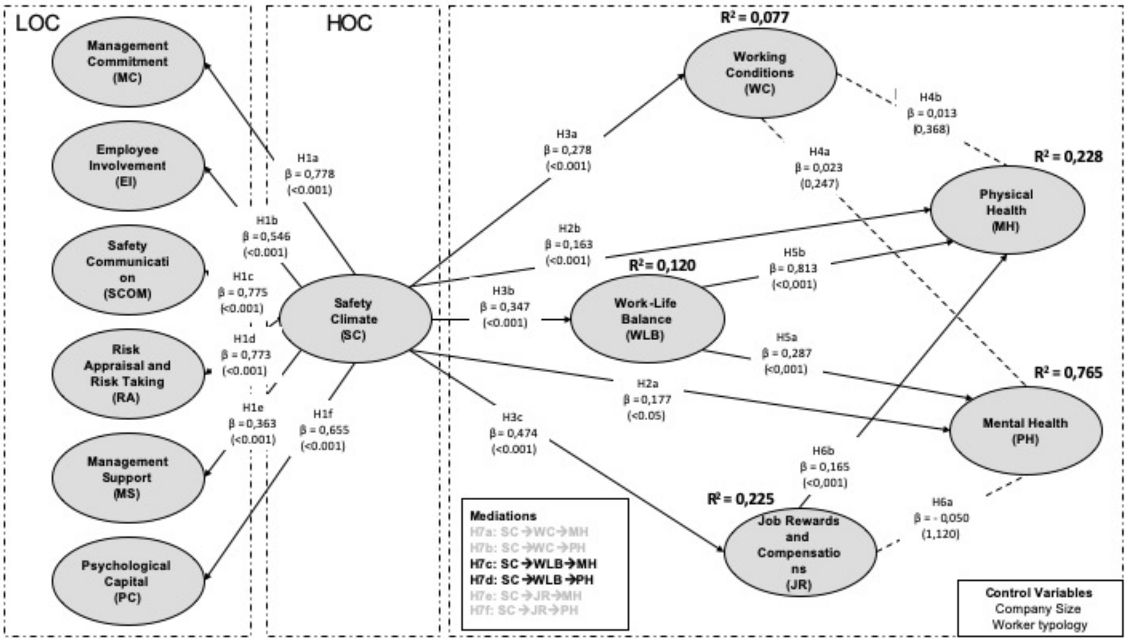
About the mediation analysis (Hypotheses 7) of the dominant variables working conditions, work-life balance, and job compensation and rewards, the significant analysis of direct and indirect effects revealed the existence of complementary mediation only in the case of work-life balance. The significance analysis of direct and indirect effects revealed only the presence of complementary mediation for the work-life balance case since both direct and indirect effects were significant and positive in both cases. Therefore, our results provide empirical support for the mediating role of work-life balance in the workers' health patterns. More specifically, work-life balance represents a mechanism underlying the relationship between safety climate and mental or physical health. Safety climate leads to work-life balance, and this, in turn, leads to mental and physical health (see Table 7)

Once the significance of the indirect effects has been established, the mediation's strength can be examined by using the total effects and the variance account for (VAF). Thus, the VAF indicates that 65.8% of the effect of safety climate on mental health is through work-life balance as a mediator, and the magnitude is considered partial. At the same time, the effect of safety climate on physical health is produced through work-life balance as a partial mediator.

Table 7
Significance analysis of the direct and indirect effects

| Hyphotesis | Direct Effect | | 95% confidence Interval of the Direct Effect | t value | Significance (p <0.05) | Indirect Effect | | 95% confidence interval of the Indirect Effect | T – value | Significance (p > 0.05) | VAF (indirect effect/total effect) | Supported |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H7a | SAFETY CLIMATE→MENTAL HEALTH | 0.163 | [0.059, 0.285] | 2.789 | YES | SAFETY CLIMATE→**WORKING CONDITIONS**→MENTAL HEALTH | 0.004 | [-0.014, 0.027] | 0,390 | NO | - | No mediation |
| H7b | SAFETY CLIMATE→PHYSICAL HEALTH | 0.177 | [-0.036, 0.361] | 8.939 | YES | SAFETY CLIMATE→**WORKING CONDITIONS**→PHYSICAL HEALTH | 0.007 | [-0.048,0.061] | 0,269 | NO | - | No mediation |
| H7c | SAFETY CLIMATE→MENTAL HEALTH | 0.163 | [0.059, 0.285] | 2.789 | YES | SAFETY CLIMATE→**WORK-LIFE BALANCE**→MENTAL HEALTH | 0.277 | [0.173, 0.379] | 5.284 | YES | 0.658 | Partial mediation |
| H7d | SAFETY CLIMATE→PHYSICAL HEALTH | 0.177 | [-0.036, 0.361] | 8.939 | YES | SAFETY CLIMATE→**WORK-LIFE BALANCE**→PHYSICAL HEALTH | 0.107 | [0.044, 0.162] | 3.314 | YES | 0.370 | Partial mediation |
| H7e | SAFETY CLIMATE→MENTAL HEALTH | 0.163 | [0.059, 0.285] | 2.789 | YES | SAFETY CLIMATE→JOB **REWARDS AND COMPENSATION**→MENTAL HEALTH | -0.023 | [-0.072, 0.013] | 1.099 | NO | - | No mediation |
| H7f | SAFETY CLIMATE→PHYSICAL HEALTH | 0.177 | [-0.036, 0.361] | 8.939 | YES | SAFETY CLIMATE→**REWARDS AND COMPENSATION** → PHYSICAL HEALTH | 0.004 | [0.008, 0.0176] | 1,875 | NO | - | No mediation |

Figure 3
Model




**Importance-Performance Analysis (IPMA)**

The IPMA contrasts structural model total effects on a specific endogenous latent variable with the average latent variable scores of this construct's predecessors. The total effects represent the predecessor constructs' importance in shaping the target construct, while their average latent variable scores represent their performance. Hence, the goal is to identify predecessors with strong significance for the target construct and relatively low performance, underlying potential areas of improvement that may receive more attention (Hair et al., 2014).

According to the results of the IPMA reported in Table 8, if we wish to increase the mental health of the workers, we should focus mainly on the work-life balance, and then on safety climate, since there is still room for improvement in terms of their performance. Similarly, in the case of physical health, safety climate variable has a significant effect, but its performance can be improved, as well as the work-life balance variable, which is below the performance obtained by job rewards and compensation.

Table 8
Importance-Performance Analysis (IPMA)

| | IMPORTANCE | PERFORMANCE | IMPORTANCE | PERFORMANCE |
|---|---|---|---|---|
| | MENTAL HEALTH (MH) | | PHYSICAL HEALTH (PH) | |
| SAFETY CLIMATE (SC) | 0.464 | 19.900 | 0.415 | 19.900 |
| WORKING CONDITIONS | 0.003 | 14.567 | 0.020 | 14.567 |
| WORK-LIFE BALANCE (WLB) | 0.807 | 26.671 | 0.269 | 26.671 |
| JOB REWARDS AND COMPENSATIONS (JR) | -0.047 | 29.228 | 0.251 | 29.228 |

**Individual characteristics control**

We have controlled by individual characteristics such as worker typology (if they have some workers under their supervision or not), and the size of the company. On the one hand, there is a low variability in most of the individual characteristics (gender, level of education, current situation, type of contract, and sector. This homogeneity in the data limits the possibility to control by these characteristics. In this case, it could be a possibility to increase the size of the sample to have more representability of each characteristic group. On the other hand, we have controlled by company's size and we have not found significant differences

## 5.5. DISCUSSION

This research studies the relationship between a multidimensional safety climate and workers' health mediated by working conditions, work-life balance, and job rewards and compensations. The results confirmed most of the relationships proposed in our theoretical model.

First, as discussed in the literature review, safety climate is not a single dimension variable (Zohar, 2000; 2014). According to the studies reviewed, there are a multitude of different factors across alternative models to measure safety climate (see Table 1). This lack of consistency in which factors must be considered in the models to measure safety climate can be due to the variety of questionnaires, samples and methodologies used by researchers (Choudhry et al., 2009). One of the aims of this study is to propose a model for measuring safety climate using the information and data from a publicly available survey (the EWCS). Another objective of our research is to incorporate in the measurement model the key variable of psychological capital, which has been suggested by some authors (Bamel et al. 2020) but omitted until now in previous models. As we explained above, we have not included some items from the European working condition survey due to the impossibility to re-code them into a 5-points Likert-scale. Therefore, an104rganizanal goal of our study is to reframe some questions of the survey to be answered in such a scale, with the intention of reinforcing the reliability and validity of working conditions factor. (See Appendix 3).

In the context of safety climate, we have considered the more salient factors proposed in the literature. After fitting our structural model, the results show that all the factors considered are significant in the explanation of safety climate, although the relative importance of the factors by their effect size is somewhat different from other previous studies (Choudhry et al., 2009; Schwatka, 2016; Zohar, 1980).

Our results show that safety climate is mainly explained by management commitment. This is consistent with previous studies that argue this is a core factor to achieve a good safety climate (Ajslev et al., 2017; Chan et al., 2017; Choudhry et al., 2009; Fang et al., 2006; Kim et al., 2021; Lindgard et al., 2012; Mosly, 2019; Niu et al., 2021; Schwatka et al., 2016; Zhou et al., 2015). The second most important factor (as per its effect size) explaining safety climates is safety communication, a result that is also in line with other previous studies (Chan et al.,2017; Choudhry et al., 2009; Kim et al., 2021; Niu et al., 2021; Schwatka et al., 2016). Management commitment and safety communication can be viewed as organizational factors, reflecting the importance of the manager's attitude towards safety issues and how it affects workers' perceptions of the relevance of safety within the company.

The three following factors in terms of their effect size on safety climate, which can be interpreted as individual factors, are: risk appraisal and risk-taking, psychological capital, and employee involvement. Our results for risk appraisal and risk-taking are consistent with findings from other studies (Chan et al., 2017; Fang et al., 2006; Kim et al., 2021; Niu et al., 2021; Wang et al. 2018; Zhou et al., 2015), and the same for employee involvement (Ajslev et al., 2017; Choudhry et al., 2009; Lindgard et al., 2012; Mosly, 2019; Schwatka et al., 2016). As we have already mentioned, to the best of our knowledge, this is the first empirical measurement of safety climate that incorporates the psychological capital factor, and moreover in the construction sector. The previous most relevant five factors that we have discussed above, which belong to organizational and individual levels, reflect that safety climate will depend on all agents involved in the effective work organization (managers) and the appropriate work

performance (workers). Thus, managers can act by improving interactions between colleagues and empowering workers, providing them with training and enhancing their skills to give them responsibility and autonomy in their work (Arocena et al., 2008). Concerning psychological capital, we highlight the need of considering and appreciating the workers' feelings and motivations, in order to raise the workers' commitment and improve their performance.
The last important factor regarding its effect size on safety climate is management support. As some studies stated, there is an effect on the workers' perception of the support they receive from the management (Ajslev et al., 2017; Kim et al., 2021). It should be noted that in some of the reviewed studies, management support is included in a broad factor comprising several organizational aspects such as encouraging their employees to work safely over pressuring them to work fast (Ajslev et al., 2017), while in other studies it is considered an independent factor, as we have done (Kim et al., 2021). A reason for these different approaches to safety support could depend on what the predominant company size is in the sample to study, and if the point is to know either the managers' or the workers' feelings. In our model, this factor refers to the workers' perception of the supportive environment and recognition of doing a safe and good job. We believe that the process of this recognition will be more direct in small and medium-sized enterprises (SMEs) because of a closer relationship between workers and managers. As 99,97% of construction companies in Spain and in UE are small and medium-sized enterprises (SMEs), which means that they have less than fifty employees (INE, 2019), we have considered management support as an independent factor in the model to measure safety climate.

Therefore, the resources and efforts of the company in the construction sector should follow this sequence to improve the safety climate in case resources are limited. Managers can improve safety climate in their companies significantly by being committed to their role as managers in terms of an effective work organization, trusting their employees, giving the example of integrating safety within the company, appreciating their workers' safe behaviors, making people work together, ensuring fluid communication between all the staff members, or positively valuing the attitude of their employees, among other actions.
Concerning workers' health, we found that mental and physical health are influenced by several factors, such as safety climate, work-life balance, and job rewards and compensations mainly.
Specifically, the critical factors affecting mental health were work-life balance and safety climate. This result is consistent with what other studies have found (Cottini & Lucifora, 2013; Gomez-Baya & Lucia-Casademunt, 2017; Punzo et al., 2018). These factors or any of their components have been proved to be important in the final health outcomes of workers.
As for physical health, we found that work-life balance is the most crucial factor, followed by job rewards and compensation, and safety climate. In addition to the factors influencing mental health, in the case of physical health, all components of job rewards and compensation should also be taken into consideration. That is economic remunerations, prospects for career advancement, job security, and management and social support. This result is in line with what Locke & Latham (1990) found by studying how all these components impacted the job satisfaction for predicting individual job performance and organizational goals meeting. Additionally, Nappo (2019) also confirmed a positive effect of job support on workers' physical health.

Our results mean that human resource managers must emphasize workers' work-life balance to improve their general health, as this aspect is affecting both mental and physical health. Thus, it is important to implement a set of interventions in the organization to improve the balance between employees' personal and professional activities. These activities could be empowering workers to self-managing the organization of their own duties, designing flexible working hours, or avoiding the assignment of stressful working loads.
Contrary to what other studies have found, our results suggest that there is not a significant direct relationship between working conditions and workers' health (hypotheses 4a mental

health and 4b physical health). Specifically, Punzo et al.'s (2018) results confirmed a significant effect of working conditions on mental health and Nappo's (2019) ones on physical health. Our divergent result could be explained by the lower capability to measure working conditions with the items available in the survey we have used (EWCS). This factor was one of the most affected when the measurement model of latent variables was determined. There were many questions of the survey regarding working conditions that had to be removed as, for example, working hours, pace of work, quantity and difficulty of work, because all of them were coded as numerical or dichotomous. For future studies, we offer in Appendix C a proposal to include some of these items measured in a 5-Likert scale to be included into a model similar to ours. It is likely that the results of the relationship between working conditions and workers' health would be different if all these missed items would be considered.
Another important finding of our research shows that work-life balance significantly mediates the relationship between safety climate and mental and physical health. This means that if the workers' perception of work-life balance is low, it can impact negatively their mental and physical health, even when the safety climate is adequate. Therefore, human resource managers should not only focus on generating a good safety climate to improve their workers' health. It would be also critical for them to understand the needs of their workers in terms of work-life balance. The combination of both factors will raise the effectiveness of managerial actions intended to improve workers' health.

As we have already stated, in order to explore the mediator effect of job satisfaction on workers' health results, we have explicitly introduced in our model three of the factors proposed by Punzo et al. (2018) to proxy job satisfaction, let's say, working conditions, work-life balance and job rewards and compensation. The factors proposed as control variables were those related to individual characteristics (age, gender, education, seniority, activity details, type of contract, company size, etc.). We did not observe much variability in many of the individual characteristics because our sample is composed mainly by males, with similar levels of primary and professional education, similar seniority, same activity and equal contract type. However, as we found some variability in company size variable, we have carried out a control analysis of this variable. Our results indicate that there is no significant categorical moderating effect of Company size is observed, and we can conclude that it is not necessary to consider different programs to improve the general health of workers in the construction sector based on the company's size. Based on the obtained results, the conclusions and recommendations can be generalized for companies of any size.

Future line of research
The usefulness of the safety climate measurements depends on their capability to represent the reality of the companies, including as many as possible different aspects. The way to obtain the items to measure those aspects is usually dependable on the specific survey to capture workers' perceptions of safety at companies. As we have used a European-wide survey that includes all sectors and asks questions that can reflect these aspects, our structural model can be replicated in other sectors, industries and countries in order to compare results. Differently to previous studies, we have explicitly reported all items that we have measured each factor using data from the European Working Condition Survey. We have also made recommendations for changing or adapting some questions of that survey, and we propose for future researches to include these modified questions or to elaborate a more complete specific questionnaire. Furthermore, it will be interesting as well to test our model with larger samples in different industries and countries to be able to compare results and making targeted proposals and, finally, check whether these findings are robust and can be generalized.

## 5.6. CONCLUSIONS

Workers' mental and physical health are influenced by several factors, including, but not limited to, safety climate, work-life balance, and job rewards and compensations.
These results have several implications for the human resources management in the construction sector, especially for implementing policies and interventions aimed to affect positively the workers' mental and physical health. The relationship between work aspects related to safety climate and some aspects of job satisfaction is essential for the human resources department. These work aspects are organizational factors that can be managed and directly affect the workers' health. Regarding our results, we can state that organizational factors are basic in creating a good safety performance. Consequently, managers' emphasis should be placed on management commitment and safety communication. Furthermore, if these factors are combined with adequate management of work-life balance, the results in the health of the workers will be improved.

***Theoretical implications***

- One objective is to validate the measures of workers' mental and physical health through an available questionnaire. The items that have not been incorporated (because they were measured in the EWCS with inappropriate scales to be included) in our model might be considered on another measurement scale (e.g., Likert, semantic differential, or Stapel scale), and after that, validate the broader measurement model.
- A second objective is to validate a measurement model for safety climate as an unobservable second-order latent construct formed by management commitment, safety communication, employee involvement, psychological capital, risk appraisal and risk-taking, and management support. All these factors were previously proposed by the literature but until now they had not been analyzed empirically as a whole with the same sample. To the best of our knowledge, this research contributes to the literature being the first empirical research, that incorporates the psychological capital factor as an element formatting safety climate.
- We propose and validate a structural model to explain workers' mental and physiological health as a function of safety climate with the mediation of some elements of job satisfaction, including working conditions, work-life balance, and job rewards and compensations.

***Practical implications***

- To establish a ranking of importance when explaining safety climate, including new factors that must be considered in future research. Managers can improve safety climate in their companies significantly by being committed to their role as managers in terms of an effective work organization, trusting their employees, setting an example of integrating safety within the company, appreciating workers' safe behaviors, making people work together, ensuring fluid communication between all the staff members, or positively valuing the attitude of their employees, among other actions.
- To contribute to enhancing mental health, special attention should be placed on work-life balance, safety climate, and finally on job rewards and compensations.

We highlight that most of these factors can be controlled and affected by specific actions from managers in organizations.

- To study safety climate through the use of the EWCS, with some recommendations to include or complete some factors. This data sample is available for any interested person and allows for comparative studies since the data are collected with a consistent and homogenous methodology across different countries in Europe.

As we have discussed, this study has various implications for human resource managers in the construction sector. We believe the implications derived from our study are helpful to take some steps toward protecting the workers' health, as one of the main goals of many international institutions such as the EU, the International Labor Organization, and the World Health Organization, among others. Our intention has been to provide a starting point to better understand which practices can be implemented by companies in order to improve the workers' health.

## 5.7. REFERENCES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# 6. DISCUSSION

This study provides empirical evidence of the companies that provided more training to their workers reported more accidents. This means that the number of accidents raises as training hours increase. This result could be explained due to most companies have not integrated prevention into their execution processes. They are carrying out more formal than effective compliance with prevention. Analyzing the training, accident, and economic data of the companies, we found that the bigger companies, regarding the number of employees, profitability, and competitiveness through their tangible assets, are more likely to have an accident. It can be due to the complexity of work in bigger sites or projects, which are more propensity of having bigger companies, and different typologies of companies working at the same site mixing employed workers with subcontractors' workers and self-employed workers. This kind of work organization could make prevention management more complicated. Regarding the training process, the courses in content and methodology, it is not designed to provide what companies and workers actually need to carry out their worker safely. There is not an objective evaluation that allows knowing if there is a transfer of knowledge to the workers. We think important to highlight that the compulsory basic training delivered with traditional methods does not reduce the accident rate. But the continuous accumulated training provided by the CLF reduces accidents in a company.

There is a complex relationship between accidents and the company's profitability. Our results show that, if managers decide their investment in safety under the paradigm of profit maximization, the optimal decision will not be adjusted to the minimum possible level of accidents. The decrease of the optimal safety company's level depends on the difference in its assessment of their possible injury costs. Likewise, we have to consider that managers do not really know the cost of accidents, as they are not completely reflected in the economic companies' analyses (EU-OSHA, 2017; Cagno et al. 2013, Micheli et al., 2015). There are several reasons why the safety costs (prevention, protection, and accident costs) are not considered enough by the managers. Furthermore, companies do not account for the real data -in quantity and quality- of the safety investment they do, or their occupational accident costs. All these costs are underreported and underestimated, especially in SMEs, as most of them do not have a human resources department and the manager or the owner is who has to carry out these tasks. The company's incentives to invest in safety must compensate for the expected costs of having accidents and their consequences. These incentives are affected when the company does not have to face the real cost of accidents suffered by its workers due to externalities. This affects the accuracy of the economic analysis taking into account all the relevant expected cost associated with occupational accidents and it also limits conducting deeper research to obtain the impact of having accidents on the companies' results and draw conclusions. More empirical and theoretical studies are needed to better understand the real economic consequences of occupational accidents and injuries on the company's performance and on the countries' economic competitiveness.

In the last part of this study, we focus on highlighting the factors that a company can manage to reduce its accidents. Our intention has been to provide a starting point to better understand which practices can be implemented by companies in order to improve the workers' health. In the context of safety climate, we have considered the more salient factors proposed in the literature and we included PsyCap as a new factor to consider in constructing safety climate. After fitting our structural model, the results show that all the factors considered are significant in the explanation of safety climate. It is important to this research contributes to the literature

being the first empirical research, that incorporates the psychological capital factor as an element formatting safety climate.
Managers can improve safety climate in their companies significantly by being committed to their role as managers in terms of an effective work organization, trusting their employees, giving the example of integrating safety within the company, appreciating their workers' safe behaviors, making people work together, ensuring fluid communication between all the staff members, or positively valuing the attitude of their employees, among other actions. Concerning workers' health, we found that mental and physical health are influenced by several factors, such as safety climate, work-life balance, and job rewards and compensations mainly.
Specifically, the critical factors affecting mental health were work-life balance and safety climate. This result is consistent with what other studies have found (Cottini & Lucifora, 2013; Gomez-Baya & Lucia-Casademunt, 2017; Punzo et al., 2018). These factors or any of their components have been proved to be important in the final health outcomes of workers.
As for physical health, we found that work-life balance is the most crucial factor, followed by job rewards and compensation, and safety climate. In addition to the factors influencing mental health, in the case of physical health, all components of job rewards and compensation should also be taken into consideration. That is economic remunerations, prospects for career advancement, job security, and management and social support. This result is in line with what Locke & Latham (1990) found by studying how all these components impacted the job satisfaction for predicting individual job performance and organizational goals meeting.

# 7. CONCLUSIONS

Occupational accidents are a difficult problem to address. The present doctoral thesis focuses on the high number of accidents, fatal and non-fatal ones, that are reported very year in the construction sector, and in analyse the different factors that a company can manage to reduce its accidents and protect its workers' health. Thereby reducing all the negative consequences that arise from them. This study contributes to the literature by empirically confirming the relationship between preventive policies of a firm and its accidents, and whether these later affect the firm's profitability. This thesis also contributes to the scarce empirical studies that connect accidents and the economic results of the companies. And finally, it contributes by establishing an order of factors that the company can manage to improve its workers' physical and mental health.

Accidents have a direct negative effect on the firms' profitability when the accident rate reaches a high level. It is important consider that nowadays is difficult to assess the real cost of an accident, since most of the costs are not assumed by the companies. In any case, the accidents have a very high cost paid by workers, their firms, and society.
For this reason, it is crucial to reduce the actual number of accidents in the construction sector and provide to workers a safety workplace. We have focus on the different factors that a company can manage to reduce its occupational accidents.
Regarding the individual factors, psychological capital is a factor that affects safety climate.
Organizational factors directly affect the workers' health and are basic a factor in creating a good safety performance. Managers can meliorate their workers' health by improving safety climate. Consequently, managers' emphasis should be placed on management commitment and safety communication. Furthermore, if these factors are combined with adequate management of work-life balance, the results in the health of the workers will be improved.

Implications and suggestions

- Continuous training with theory and practices is the one that has a better effect on reducing accidents.
    - The training has to be thoroughly reviewed in content and the methods used to deliver it to employees.
- The firm's economic results are not negatively affected by accidents in most cases, at least in an expansion economic period, it is necessary to implement policies that make the managers see it as a necessary goal to achieve.
    - The administration would introduce some changes in a medium-term effect, to make firms co-responsible of their policies and safety results.
    - More research is needed to clarify the economic relationship between accidents and the economic results, as well as to help firms to introduce the different processes within the firm.
- To establish a ranking of importance when explaining safety climate, including new factors that must be considered in future research.
- To improve their worker's health, companies have to consider:
    - Individual factors: risk appraisal and risk-taking, psychological capital and work-life balance
    - Organizational factors: safety communication, management commitment.
    - Managers can lead these changes by including prevention within all the firms' processes.
- Workers have to understand the need of their implications of these safety issues.

# APPENDIX

## APPENDIX A

| Constructs (Latent Variables) | | | |
|---|---|---|---|
| Management Commitment | | | |
| MC11 | Q70a | Employees are appreciated when they have done a good job | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| MC12 | Q70b | The management trusts the employees to do their work well | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| MC13 | Q70d | The work is distributed fairly | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| Employee Involvement | | | |
| EI11 | Q61d | You are involved in improving the work organisation or work processes of your department or organisation | 1. Always / 2. Most of the time / 3. Sometimes / 4. Rarely / 5. Never |
| EI12 | Q61i | You are able to apply your own ideas in your work | 1. Always / 2. Most of the time / 3. Sometimes / 4. Rarely / 5. Never |
| EI13 | Q61n | You can influence decisions that are important for your work | 1. Always / 2. Most of the time / 3. Sometimes / 4. Rarely / 5. Never |
| EI14 | Q61f | You can take a break when you wish | 1. Always / 2. Most of the time / 3. Sometimes / 4. Rarely / 5. Never |
| EI15 | Q61g | You have enough time to get the job done | 1. Always / 2. Most of the time / 3. Sometimes / 4. Rarely / 5. Never |
| Safety Communications | | | |
| SCOM11 | Q63e | Your immediate boss provides useful feedback on your work | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| SCOM12 | Q70c | Conflicts are resolved in a fair way | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| SCOM13 | Q70e | There is good cooperation between you and your colleagues | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| Risk Appraisal and Risk Taking | | | |
| RA11 | RQ29a | Are you exposed at work to Vibrations from hand tools, machinery, etc? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |

| | | | |
|---|---|---|---|
| RA12 | RQ29b | Are you exposed at work to Noise so loud that you would have to raise your voice to talk to people? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |
| RA13 | RQ29c | Are you exposed at work to High temperatures which make you perspire even when not working? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |
| RA14 | RQ29d | Are you exposed at work to Low temperatures whether indoors or outdoors? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |
| RA15 | RQ30a | Does your main paid job involve tiring or painful positions? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |
| RA16 | RQ30c | Does your main paid job involve carrying or moving heavy loads? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |
| Management Support | | | |
| MS11 | Q63a | Your immediate boss respects you as a person | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| MS12 | Q63b | Your immediate boss gives you praise and recognition when you do a good job | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| MS13 | Q63c | Your immediate boss is successful in getting people to work together | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| MS14 | Q63d | Your immediate boss is helpful in getting the job done | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| MS15 | Q63f | Your immediate boss encourages and supports your development | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| Psychological Capital | | | |
| PC11 | RQ87a | Over the last two weeks, I have felt cheerful and in good spirits | 1. All of the time / 2. Most of the time / 3. More or less than half of the / 4. Some of the time / 5. At no time |
| PC12 | RQ87b | Over the last two weeks, I have felt calm and relaxed | 1. All of the time / 2. Most of the time / 3. More or less than half of the / 4. Some of the time / 5. At no time |

| | | | |
|---|---|---|---|
| PC13 | RQ87c | Over the last two weeks, I have felt active and vigorous | 1. All of the time / 2. Most of the time / 3. More or less than half of the / 4. Some of the time / 5. At no time |
| PC14 | RQ87d | Over the last two weeks, I woke up feeling fresh and rested | 1. All of the time / 2. Most of the time / 3. More or less than half of the / 4. Some of the time / 5. At no time |
| PC15 | RQ87e | Over the last two weeks, my daily life has been filled with things that interest me | 1. All of the time / 2. Most of the time / 3. More or less than half of the / 4. Some of the time / 5. At no time |
| Working Conditions | | | |
| WC11 | RQ30h | Does your main paid job involve being in situations that are emotionally disturbing for you? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |
| WC12 | RQ30g | Does your main paid job involve handling angry clients, customers, patients, pupils etc.? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |
| Work-Life Balance | | | |
| WLB11 | RQ45a | How often in the last 12 months, have you kept worrying about work when you were not working? | 5. Always / 4. Most of the time / 3. Sometimes / 2. Rarely / 1. Never |
| WLB12 | RQ45b | How often in the last 12 months, have you felt too tired after work to do some of the household jobs which need to be done? | 5. Always / 4. Most of the time / 3. Sometimes / 2. Rarely / 1. Never |
| WLB13 | RQ45c | How often in the last 12 months, have you found that your job prevented you from giving the time you wanted to your family? | 5. Always / 4. Most of the time / 3. Sometimes / 2. Rarely / 1. Never |
| WLB14 | RQ45d | How often in the last 12 months, have you found it difficult to concentrate on your job because of your family responsibilities? | 5. Always / 4. Most of the time / 3. Sometimes / 2. Rarely / 1. Never |
| WLB15 | RQ45e | How often in the last 12 months, have you found that your family responsibilities prevented you from giving the time you should to your job? | 5. Always / 4. Most of the time / 3. Sometimes / 2. Rarely / 1. Never |
| WLB16 | RQ46 | Over the last 12 months, how often have you worked in your free time to meet work demands? | 5. Daily / 4. Several times a week / 3. Several times a month / 2. Less often / 1. Never |
| Job Rewards and Compensations | | | |
| JR11 | Q89a | Considering all my efforts and achievements in my job, I feel I get paid appropriately | 1. Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| JR12 | Q89b | My job offers good prospects for career advancement | 1. Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| JR13 | Q89d | I generally get on well with my work colleagues | 1. Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |

| | | | |
|---|---|---|---|
| JR14 | Q61b | Your manager helps and supports you | 1. Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| JR15 | Q63b | Your immediate boss gives you praise and recognition when you do a good job | 1. Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| JR16 | Q63f | Your immediate boss encourages and supports your development | 1. Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| Mental Health | | | |
| MH11 | RQ79a | Over the last 12 months, how often did you have difficulty falling asleep? | 5. Daily / 4. Several times a week / 3. Several times a month / 2. Less often / 1. Never |
| MH12 | RQ79b | Over the last 12 months, how often did you have waking up repeatedly during the sleep? | 5. Daily / 4. Several times a week / 3. Several times a month / 2. Less often / 1. Never |
| MH13 | RQ79c | Over the last 12 months, how often did you have waking up with a feeling of exhaustion and fatigue? | 5. Daily / 4. Several times a week / 3. Several times a month / 2. Less often / 1. Never |
| MH14 | RQ61m | You experience stress in your work | 5. Always / 4. Most of the time / 3. Sometimes / 2. Rarely / 1. Never |
| MH15 | RQ61o | Your job requires that you hide your feelings | 5. Always / 4. Most of the time / 3. Sometimes / 2. Rarely / 1. Never |
| Physical Health | | | |
| PH11 | RQ78a | Over the last 12 months, did you have hearing problems? | 1. No / 2. Yes |
| PH12 | RQ78b | Over the last 12 months, did you have skin problems? | 1. No / 2. Yes |
| PH13 | RQ78c | Over the last 12 months, did you have backache? | 1. No / 2. Yes |
| PH14 | RQ78d | Over the last 12 months, did you have muscular pains in shoulders, neck and/or upper limbs (arms, elbows, wrists, hands etc.)? | 1. No / 2. Yes |
| PH15 | RQ78e | Over the last 12 months, did you have muscular pains in lower limbs (hips, legs, knees, feet etc.)? | 1. No / 2. Yes |
| PH16 | RQ78f | Over the last 12 months, did you have headaches, eyestrain? | 1. No / 2. Yes |
| PH17 | RQ78g | Over the last 12 months, did you have injuries? | 1. No / 2. Yes |

APPENDIX B

List items removed with low community values (less than 0.70).

| | | | |
|---|---|---|---|
| Constructs (Latent Variables) | | | |
| Management Commitment | | | |
| MC21 | Q67a | The training has helped me improve the way I work | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| Employee Involvement | | | |

| | | | |
|---|---|---|---|
| EE21 | Q61a | Your colleagues help and support you | 1. Always / 2. Most of the time / 3. Sometimes / 4. Rarely / 5. Never |
| EE22 | Q70f | In general, employees trust management | 1.Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| Risk Appraisal and Risk Taking | | | |
| RA17 | RQ29f | Are you exposed at work to breathing in vapours such as solvents and thinners? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |
| RA18 | RQ29g | Are exposed at work to handling or being in skin contact with chemical products or substances? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |
| RA19 | RQ29i | are you exposed at work to Handling or being in direct contact with materials which can be infectious, such as waste, bodily fluids, laboratory materials, etc.? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |
| RA20 | RQ30d | Does your main paid job involve Sitting? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |
| RA21 | RQ30e | Does your main paid job involve Repetitive hand or arm movements? | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |
| Job Rewards and Compensations | | | |
| JR11 | Q89g | I might lose my job in the next 6 months | 1. Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |

APPENDIX C

List of recommended items to include as a Likert scale response

| Management Commitment | | | | |
|---|---|---|---|---|
| | | | Actual response scale | Proposed response scale |
| MC21 | Q65aR | Does your employer provide you the needed safey training? | YES/ NO/ DK/REF | 1. Always / 2. Most of the time / 3. Sometimes / 4. Rarely / 5. Never |
| MC22 | Q31aR | Does your employer provide you the needed personal protective equipment? | YES/ NO/ DK/REF | 1. Always / 2. Most of the time / 3. Sometimes / 4. Rarely / 5. Never |
| MC23 | Q71aR | If it exists, are you involved in trade union, works council or a similar committee at your company or organisation? | YES/ NO/ DK/REF | 1. Strongly agree / 2. Tend to agree / 3. Neither agree nor |

| | | | | |
|---|---|---|---|---|
| | | | | disagree / 4. Tend to disagree / 5. Strongly disagree |
| MC24 | Q71bR | If it exists, are you informed of the activities of the Health and safety delegate or committee? | YES/ NO/ DK/REF | 1. Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| MC25 | Q71cR | If it exists, are you involved in regular meetings in which employees can express their opinion about what is happening in the organisation | YES/ NO/ DK/REF | 1. Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| Employee Involvement | | | | |
| EE22 | Q31 | Does your job ever require that you wear personal protective equipment? | YES/ NO/ DK/REF | 1. Always / 2. Most of the time / 3. Sometimes / 4. Rarely / 5. Never |
| EE23 | Q32 | Do you always use it when it is required? | YES/ NO/ DK/REF | 1. Always / 2. Most of the time / 3. Sometimes / 4. Rarely / 5. Never |
| Working Conditions | | | | |
| WC21 | RQ42 | Are your satisfied with your working time arrangements set? | 1/2/3/4/DK/REF | 1. Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| WC22 | Q50c | On the whole, is your pace of work dependent on numerical production targets or performance targets | YES/ NO/ DK/REF | 1. Strongly agree / 2. Tend to agree / 3. Neither agree nor disagree / 4. Tend to disagree / 5. Strongly disagree |
| WC23 | Q53R | Does your main paid job involve complex tasks? | YES/ NO/ DK/REF | 5. All of the time + Almost all of the time / 4. Around ¾ of the time / 3. Around half of the time / 2. Around ¼ of the time / 1. Almost never + Never |

Note: R= Reformulated question