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OHSAS 18001 certification and work accidents: Shedding light on the connection

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ABSTRACT

Introduction: The implications of OHSAS 18001 for substantive Occupational Health and Safety outcomes such, as a reduction in work accidents, have been under-researched in the scholarly literature. The impact of this standard on other aspects of performance, such as profitability and productivity, has attracted more attention. *Method:* This article aims to fill this gap by shedding light on the relationship between OHSAS 18001 certification and the rates of minor, serious, and fatal accidents per employee at work experienced in certified and non-certified companies. *Results:* Based on an analysis of a sample of 5,147 Spanish firms, the findings show that OHSAS 18001 certification is only loosely related with better occupational health and safety performance measured in terms of rate of accidents at work. A propensity for OHSAS 18001 certification to be found in economic sectors of activity with worse occupational health and safety outcomes in terms of rate of work-related accidents is identified. There is evidence of a *negative* selection-effect of the main international management standard for occupational health and safety. Potential distortions and biases that may be related to these and other findings in the scholarly literature are analyzed. Managerial implications of the main findings, implications for policy makers, and avenues for future research are discussed.

1. Introduction

A growing number of organizations have implemented an occupational health and safety (OH&S) management system, a safety management system (SMS) designed to formalize and systematize OH&S policies and practices (Degan, Lippiello, & Pinzari, 2009). In doing so, the OHSAS 18001 Standard has been the main international reference standard to date (Bayram, Ungan, & Ardic, 2017; Fernández-Muñiz, Montes-Peón, & Vázquez-Ordás, 2012a; Granerud & Rocha, 2011). Perhaps the main attractive feature of the OHSAS 18001 that has facilitated its widespread adoption is its compatibility with the most widely disseminated quality (ISO 9001) and environmental (ISO 14001) certifiable management systems standards (Abad et al., 2013). OHSAS 18001 was published by the British Standards Institution and came into effect in 1999 as a result of the work carried out by a group of certifying bodies from 15 countries (Fernández-Muñiz, Montes-Peón, & Vázquez-Ordás, 2012b). But the recently defined ISO 45001 standard for OH&S, though not without its problems (Heras-Saizarbitoria, Ibarloza, & de Junguitu, 2017), could be a competitor for the standard.

The promoters and supporters of OHSAS 18001 claim that the standard fosters a safe and healthy working environment by providing a framework that helps organizations to reduce the potential for accidents (OHSAS Project Group, 2007). Nevertheless, the scholarly literature on this issue is very limited (Fernández-Muñiz et al., 2012b) and inconclusive (Ghahramani, 2016a). As Lo, Pagell, Fan, Wiengarten, and Yeung (2014) pointed out, there are conflicting views and little empirical evidence that scrutinizes the link between OHSAS 18001 certification and performance. For the adoption of OHSAS 18001 many diverse aspects related to the performance of the main international standard for OH&S have been studied. Various aspects, such as the impact on safety performance (Lo et al., 2014), safety management practices (Vinodkumar & Bhasi, 2011), labor productivity (Halíčková, Basovníková, & Pavlíková, 2016), and the impact on financial performance (Fan & Lo, 2012) have been studied. The plethora of scholarly work that analyzes the impact of both ISO 9001 and ISO 14001 on the performance of the certified companies (Heras-Saizarbitoria & Boiral, 2013) has established precedents for those empirical studies of OHSAS 18001. But, as stressed by Abad et al. (2013), the effectiveness of a safety standard such as OHSAS 18001 'should be evaluated on the basis of final

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safety outcomes, such as the rate of accidents or injuries at the workplace' (Abad et al., 2013; p. 48). Surprisingly, and with very few exceptions (Abad et al., 2013; Ghahramani & Summala, 2017), this issue has not been researched in the scholarly literature of the field.

Taking this gap into consideration, this article aims to shed light on the impact of OHSAS 18001 on organizational OH&S outcomes such as work accidents. Studying the real effects of OHSAS 18001 on OH&S performance is even more necessary now, in order to analyze the real outcomes of the international reference standards for SMS, as a trend to implement and certificate ISO 45001 is expected by its promoters and supporters. The remainder of the paper is organized as follows. First, the literature review and the hypotheses are presented. Second, the method used in the empirical study is described. Third the main findings of the empirical study are presented. Lastly, the main conclusions, limitations and avenues for future research are discussed.

2. Literature review

Three main characteristics are apparent in the review of the scholarly literature work that analyzes the connection between OHSAS 18001 and performance. First, many studies are based on exploratory work and the findings should be analyzed with caution. Second, as is the case of ISO 9001 and ISO 14001 (Heras-Saizarbitoria & Boiral, 2015), there is a need to distinguish studies based third-party data and self-reported data obtained from the organization. The former compared are more reliable than the latter (Heras et al., 2002; Levine & Toffel, 2010; Heras-Saizarbitoria, Dogui, & Boiral, 2013) because of various distortions that arise in self reporting, such as social desirability bias and the rhetoric of success. Third, as stated in the introduction, a wide range of performance are analyzed rather than focusing on the main safety indicators (the alleged objective of SMSs). Considering these issues, this literature review focuses on empirical studies published in international journals that examine the main performance outcomes of the main global standard for OH&S. The review will focus on work that has analyzed the impact of OHSAS 18001 on performance and will not consider studies that have analyzed the benefits or outcomes of OHSAS 18001 (e.g. Santos, Barros, Mendes, & Lopes, 2013).

The impact of OHSAS 18001 on the financial performance of the certified companies has been analyzed in a way analogous to previous studies of the impact of ISO 9001 on the performance of the certified companies (e.g. Heras et al., 2002; Corbett, Montes-Sancho, & Kirsch, 2005). Fan and Lo (2012) found that OHSAS 18001 adoption had a positive impact on the sales performance of 44 U.S. certified companies in the fashion and textile industry and a negative impact on the companies' Return on Assets (ROA). Halíčková et al. (2016) found a positive but not very significant effect of OHSAS 18001 certification on the financial performance of 50 companies in the Czech Republic. Ionascu, Ionascu, Sacarin, and Minu (2017) studied the impact of certification on the financial performance of 67 non-financial companies and they found a positive relationship between OHSAS 18001 and financial performance.

Other studies have focused on the impact of OHSAS 18001 on other business and operational performance indicators. Halíčková et al. (2016) found a positive impact of OHSAS 18001 on labor productivity. But the most frequently used performance measures are those related to safety management. In a qualitative study carried out in eight chemical companies in India, Vinodkumar and Bhasi (2011) found that OHSAS 18001 certified organizations show statistically significantly higher levels of outcomes for safety management practices and safety behavior compared with non-certified firms. Similarly, Paas, Reinhold, and Tint (2015a) concluded from a qualitative study carried out in 16 Estonian manufacturing firms that OHSAS 18001 certification supports companies' commitment to OH&S activities and leads them to deal with issues promoting OH&S.

A limited set of studies analyze the impact of OHSAS 18001 on a diverse set of performance indicators (Halíčková et al., 2016; Lo et al., 2014). The study carried out by Lo et al. (2014) can be highlighted because of the reputation of the journal in which it was published. Based on a sample of 211 U.S. manufacturing firms, this study analyzed the impact of OHSAS 18001 certification on safety performance, financial performance (sales growth and ROA), and labor productivity. The quantitative study found a positive and significant relationship between OHSAS 18001 certification and safety performance, financial performance (sales growth and ROA), and labor productivity.

Finally, a very limited number of empirical works have analyzed the impact of OHSAS 18001 on safety performance (Abad et al., 2013; Riaño-Casallas et al., 2016; Palačić, 2017; Ghahramani & Summala, 2017; Silva et al., 2017), and even fewer studies have focused on a more detailed substantive indicator of safety performance, namely accidents in the work place.

The findings of these studies are inconclusive. In a qualitative study carried out in four Colombian companies from the petrochemical sector, Riaño-Casallas et al. (2016) found a decrease in neither the severity nor the frequency of workplace accidents associated with OHSAS 18001 certification. Similarly, Ghahramani and Summala (2017) did not find a significant effect of OHSAS 18001 certification in Iran in an exploratory study carried out in six companies (three OHSAS 18001-certified and three non-certified). In contrast to those results, Abad et al. (2013) found that the adoption OHSAS 18001 decreased the rate of work accidents for certified companies on the basis of an empirical study of 149 Spanish firms. Palačić (2017) found a similar decrease in the number of occupational accidents, injuries, and fatalities at work in their study of 37 Croatian companies, and Bayran et al. (2017) found a direct positive relationship between OH&S prevention and the decrease in accident costs in a study in Turkey with a sample of 159 OHSAS 18001 certified companies. In addition to the specific case of standards for SMS, the potential advantages of formalization and systematization of the main organizational processes to reduce working accidents - as managers can identify and eliminate hazardous practices and add safety precautions - have been demonstrated by Levine and Toffel (2010). They studied the adoption of ISO 9001 in a matched sample of nearly 1000 companies in California, and found injury rates had slightly declined for ISO 9001 adopters. These findings reported in the scholarly literature lead us to posit the following hypothesis:

H1. *OHSAS 18001 certification is related to better organizational Occupational Safety Performance, i.e. better outcomes in terms of work place accidents.*

With few exceptions (Ionascu et al., 2017; Levine & Toffel, 2010) the previously analyzed works do not emphasize that their findings should be interpreted with caution, as organizational performance may be affected by a variety of complex factors not taken into account in the research. Nor did they mention possible biases, such as reverse causality, or selection- and treatment-effects. It would be interesting to analyze whether OHSAS 18001 certification is more common in economic sectors of activity with more work accidents. Abad et al. (2013) showed empirically that the adoption of SMS is heavily conditioned by the industrial sector of activity of the certified organizations.

In the light of the theoretical and empirical findings about the main certifiable management system standards, it can be supposed that businesses with more workplace accidents could more likely to implement and certificate OHSAS 18001, giving rise to a potential selection effect. Previous scholarly research has concluded that ISO 9001 and ISO 14001 standards are mainly adopted for reasons of legitimation (Boiral, 2012; Heras-Saizarbitoria & Boiral, 2015; Ferrón-Vílchez, 2016; Iatridis & Kesidou, 2018) and it is likely that OHSAS certification would have a similar driver. Using information for 136 businesses from five European countries, Harms-Ringdahl et al. (2000) found that the improvement of corporate image was one of the top reasons for adopting a certified SMS. Similarly, Chen, Wu, Chuang, and Ma (2009) concluded that the decision to implement the OHSAS 18001 standard was primarily conditioned by top management decisions related to

Table 1
Distribution of the business sample and population by sector and size.

	Less than 10		From 10 to 49		From 50 to 249		From 250 to 499		500 or more		Total	
	Sam.	Popul.	Sam.	Popul.	Sam.	Popul.	Sam.	Popul.	Sam.	Popul.	Sam.	Popul.
Agriculture, cattle ind., fish	124	37,868	100	5770	95	958	18	83	14	31	351	44,710
Extract. and manufact. Industries	143	48,167	158	15,186	127	2498	26	208	15	73	469	66,132
Chemical industry	80	6783	104	2771	97	813	30	98	17	40	328	10,505
Metal	95	30,061	141	11,756	129	2260	34	298	35	121	434	44,493
Other Industries	127	43,182	145	10,207	103	1465	25	107	21	51	421	55,012
Building	126	127,508	146	30,458	104	3209	18	122	7	33	401	161,330
Trade, hospitality	199	244,541	163	44,751	110	5388	33	530	33	313	540	295,523
Transport., communications	113	35,490	122	10,587	106	1589	27	162	37	145	405	47,493
Finance, estate agencies	158	168,075	129	14,532	146	6005	47	828	51	478	531	199,918
Public admin. and education	97	38,096	149	16,747	143	4989	35	492	41	426	465	60,750
Health and vet. & social services	90	21,220	110	6854	131	2162	39	365	58	379	428	30,980
Other social & personal activities	127	91,513	114	9668	95	1601	22	110	16	58	374	102,950
Total	1427	892,504	1581	189,287	1388	32,937	354	3400	345	2148	5147	1,120,276

Source: Prepared by the authors with data obtained from the INSHT.

the improvement of corporate image. As a result, OHSAS 18001 might be interpreted as a signal of a firm's commitment to health and safety management, whatever its outcomes. That commitment may be more important for firms with higher OH&S challenges and worse performance (i.e., worse outcomes in terms of work place accidents). As underlined by Lo et al. (2014), given the increasing demand for organizations to at least appear to meet expectations about health and safety, such pressure might be a powerful driver toward certification.

This specific issue has not been analyzed in depth before for the case of the adoption of certifiable SMSs, although it has been extensively researched for EMSs. From a theoretical perspective, many works in the scholarly literature (Bansal & Bogner, 2002; King, Lenox, & Terlaak, 2005) had concluded that regulatory and stakeholder pressures can influence the worst performers to have a higher rate of EMS certification. It has been suggested that stakeholder groups might scrutinize the activities of the worst performers (Bansal & Bogner, 2002) and, as a result, these firms tend to be more proactive in managing institutional pressures. That is they may seek certification in order to deflect negative scrutiny by stakeholders. However, as suggested by legitimacy theory, external pressures can lead to superficial or symbolic adoption of certifiable management standards such as ISO 9001, ISO 14001 and OHSAS 18001 (Boiral, 2012; Ferrón-Vílchez, 2016; Heras-Saizarbitoria & Boiral, 2015), and standards for SMSs (Silva et al., 2017). From this perspective, certified organizations tend to adopt recognized management standards to improve their social legitimacy rather than their internal practices and performance (Aravind & Christmann, 2011; Boiral, Guillaumie, Heras-Saizarbitoria, & Tayo Tene, 2018; Heras-Saizarbitoria et al., 2013). As a result, the prevalence of certifiable standards in certain sectors of activity does not necessarily indicate the internalization[1] of those standards or the higher performance of certified organizations. According to legitimacy theory (Boiral, 2012; Christmann & Taylor, 2006), the prevalence of certifiable standards may reflect the organizational search for institutional legitimacy in response to greater pressure from environmental impacts, OH&S risks, or quality issues.

This relationship has been empirically tested in various studies. For example, Bellesi, Lehrer, and Tal (2005) in Israel and Lagodimos, Chountalas, and Chatzi (2007) in Greece found a tendency toward EMS certification in sectors with environmentally hazardous processes and activities. Similarly, in a study carried out with 3152 automotive suppliers in the United States, Canada, and Mexico, Delmas and Montiel (2008) found that companies reporting to the Toxic Release Inventory were more likely to implement and certify ISO 14001. More recently, based on data from 3658 European companies that implemented and certified in the European Eco-Management and Audit Scheme (EMAS), Heras-Saizarbitoria, Arana, and Boiral (2015) found that the adoption intensity of EMSs is six times greater in sectors with worse environmental performance (i.e., higher environmental impact).

By analogy, it is to be expected that, in sectors where there is a higher concentration of workplace accidents, the prevalence of OHSAS 18001 certification will also be higher. Therefore, based on the previous evidence, this second hypothesis is posited:

H2. *OHSAS 18001 certification is more likely in economic sectors of activity with worse Occupational Safety Performance, i.e. worse outcomes in terms of work accidents.*

3. Material and methods

Data for this empirical analysis was obtained from the Spanish National Survey on Health and Safety Management in Companies (ENGE) published in 2010 carried out by the Spanish National Institute of Occupational Safety and Health (INSHT), a scientific-technical body of the Spanish central administration. The universe of the survey (1,120,276 units) was made up of companies of all economic activities with at least one employee.

As shown in Table 1, a sample stratified by sector and size of 5147 organizations was defined from a universe of 1,120,276 organizations. A minimum of 325 organizations were interviewed for each sector of activity. In order to promote the representativeness of the largest firms and to reduce the error of these groups (see Table 2), a criterion of disproportion based on the square root of the number of workers was established. For example, for the first of the activity sectors included in Table 1 (agriculture, cattle industry and fish), 124 from 37,868 organizations that employed less than 10 workers and 14 from 31 with 500 or more employees were included in the total sample of 5147 interviewed organizations in the fieldwork. These 124 and 14 firms were considered representative of all the firms with the same characteristics, namely, the sector of activity and size. Using this criterion, there are no strata with errors greater than ±5.5% and the error for the whole of the sample is ±1.39% for a confidence level of 95.5% (two sigma) and P = Q.

The survey was conducted based on personal interviews with managers, using a rigorous interview-protocol to determine the number and the category of the work accidents in each organization.[2] In order to avoid potential distortions in the managers' reports, when possible a

[1] Nair and Prajogo (2009) point out that the internalization of a certifiable management standard entails an active use of the underlying practices of the standard to modify behavior and decision making. As stressed by these authors, internalization is particularly relevant to the examination of certifiable standards as it represents the process of absorbing both tacit and explicit information into the organization and translating it into knowledge (Nair & Prajogo, 2009).

[2] For a more detailed description of the methodology used in the fieldwork see ENGE (2010).

Table 2
Sample error by range of sector, activity and size.

Sector	Error %	Activity	Error %	Size	Error %	Global error %
Agriculture	5.32	Agriculture, cattle ind., fish	5.32	Less than 10	2.60	1.39
Industry	2.45	Extract. and manufact. Industries	4.60			
		Chemical industry	5.43	From 10 to 49	2.50	
		Metal	4.78			
		Other Industries	4.86	From 50 to 249	2.63	
Building	4.99	Building	4.99			
Service	1.91	Trade, hospitality	4.30	From 250 to 499	5.03	
		Transport., communications	4.95			
		Finance, estate agencies	4.33	500 or more	4.93	
		Public. admin and education	4.62			
		Health and vet. & social services	4.80			
		Other social & personal activities	5.16			

Source: Prepared by the authors with data obtained from the INSHT. Note: In each of the first three columns is shown the ± error of each group calculated according to the number of companies analyzed in the sample and the total in the universe belonging to each sector, activity and dimension group for a confidence level of 95.5% (two sigma) and P = Q. In the last column the global error is shown.

Table 3
Relationship between OHSAS 18001 certification and the average number of accidents.

	Minor			Serious			Fatal		
	Total	OHSAS Yes	OHSAS No	Total	OHSAS Yes	OHSAS No	Total	OHSAS Yes	OHSAS No
Accidents per 1000 employees	59.390	54.304	62.362	1.097	0.803	1.268	0.245	0.586*	0.046*

* Significant differences for a significance level α = 0.05 applying the Mann–Whitney U two-tailed test.

set of items were checked with third-party data, such as the specific sector of activity (NACE code), the size of the organization (Logarithm of the number of employees), OHSAS 18001 certification (Yes/No), and the number of minor, serious and fatal work accidents experienced in the previous two years. In order to test the two hypotheses, the available data were divided in two groups. The first group was formed of 1898 companies with OHSAS certification and the second by 3249 non-certified companies.

Regarding work accidents the following types of accidents were measured: minor accidents with work leave (accidents followed by work leave because of that accident); serious work accidents (those that result in amputations, trauma, second- and third-degree burns, severe injuries to the hand, spine or eyes and incapacitate the victim); and fatal accidents (those that lead to the death of the victim).

Using these data, first, a descriptive analysis was conducted based on the proportions, means, and correlations. Taking into account these results, a stepwise linear regression model was used. The objective of this model was to test the mediation effect of the sector and size on the strength of the relationship between OHSAS certification and the rate of accidents at work per employee. In the first step, the OHSAS 18001 certificate is introduced, subsequently the sector information and in the last the size, measured as the logarithm of the number of employees to reduce the distortions of the extreme values. This methodology allows us to analyze the mediation of the sector and size variables in the influence of OHSAS adoption and certification on accidents.

4. Results

4.1. Descriptive analysis

First, we have compared the rate of accidents at work (number of accidents divided by employees) that occurred in the two samples, applying the Mann–Whitney U test (Table 3). In the cases of fatal accidents per employee in each company, the sample of certified companies shows a statistically significantly higher mean compared to OHSAS 18001 non-certified companies. For this reason, the analysis was modified and a two-tailed test analysis was applied to observe whether significant differences were observed between the two samples for fatal accidents.

Subsequently, the causes of these results were further analyzed. We tested whether the samples were uniform in terms of size and sector distribution. As can be observed in Table 4, there is a negative and significant correlation between the number of employees of the companies and the number of minor accidents per employee.

As shown in Table 5, OHSAS 18001 certification does not have a homogeneous sectoral distribution. Significant differences in the mean of the rate of accidents at work depending on the sector to which the company belongs, in the case of minor, serious, and fatal accidents, are confirmed (see Table 5). There were more accidents in three groups: "Agriculture, cattle industry and fishing," "Metal industry," and "Building" for minor accidents, "Metal Industry" for serious accidents, and "Extractive and manufacturing industry" for fatal workplace accidents. There are two sectors with a significantly higher proportion of certified

Table 4
Correlation indexes of the size of the company and the average number of accidents.

Log(employees)	Minor			Serious			Fatal		
	Total	OHSAS Yes	OHSAS No	Total	OHSAS Yes	OHSAS No	Total	OHSAS Yes	OHSAS No
Accidents per employee	−0.079**	−0.104**	−0.063**	−0.013	−0.037	−0.004	−0.026	−0.038	0.007

** Significant correlation indexes for a significance level α = 0.01 applying Pearson method (two-tailed test).

Table 5
Relationship between the sector distribution, OHSAS 18001 certification, the size of companies, the number of work accidents and the number of work accidents per employee.

	Comp.	OHSAS %	Correl. size	Accidents per 1000 employees		
				Minor	Serious	Fatal
Agriculture, cattle ind., fish	351	0,333	−0,043[a]	77,037[a]	0,780	0,121
Extract. and manufact.. indust.	468	0,367	−0,042[a]	75,720	1371	0,782[b]
Chemical industry	328	0,369	0,016	63,919[b]	1353	0,003
Metal industry	436	0,424[b]	0,041[a]	111,997[a]	2674[a]	0,258
Other Industries	421	0,394	−0,028[b]	67,829	0,620	0,264
Building	399	0,446[a]	−0,059[a]	149,503[a]	3239	0,124
Trade, hospitality	541	0,379	−0,051[a]	27,367[d]	0,428	0,000
Transport., communications	405	0,373	0,018	47,337	0,402	0,068
Finance, estate agencies	531	0,377	0,036[b]	27,593[c]	0,711	0,075
Public admin. and education	465	0,286[c]	0,053[a]	18,300[c]	0,173	0,020
Health & vet. & social serv.	428	0,341	0,095[a]	37,602	1570	0,002
Other social & pers. activities	374	0,332	−0,039[a]	32,006[c]	0,112[c]	1341
Total	5,147	0,368		59,390	1097	0,245

[a] Sector with proportion of OHSAS certified companies or number of accidents significantly higher for a level of significance $\alpha = 0.01$, applying in the first case the test of difference of proportions and in the second the Mann–Whitney U test (two tailed test).
[b] Sector with proportion of OHSAS certified companies or number of accidents significantly higher for a level of significance $\alpha = 0.05$, applying in the first case the test of difference of proportions and in the second the Mann–Whitney U test (two tailed test).
[c] Sector with proportion of OHSAS certified companies or number of accidents significantly lower for a level of significance $\alpha = 0.01$, applying in the first case the test of difference of proportions and in the second the Mann–Whitney U test (two tailed test).
[d] Sector with proportion of OHSAS certified companies or number of accidents significantly lower for a significance level $\alpha = 0.05$, applying in the first case the test of difference of proportions and in the second the Mann–Whitney U test (two tailed test).

Table 6
Relationship between OHSAS 18001 certification in each sector and the number of accidents by NACE sectors.

	Minor	Serious	Fatal
% OHSAS	0.625[a]	0.617[a]	−0.061

[a] Significance level $\alpha = 0.01$ two-tailed test. Note: 51 subsectors, first two digits of their NACE code.

companies: "Metal industry" and "Building." In both these sectors the means for the rate of minor accidents, and the "Metal industry" the mean of the rate of serious work accidents, are significantly higher for $\alpha = 0.01$. The sector with a significantly lower proportion of OSHAS 18001 certification is "Public administration and education," which also has a smaller mean of minor working accidents per employee for $\alpha = 0.01$.

A correlation analysis of the proportion of certified companies in each sector with the rate of minor, serious and fatal working accidents per employee was performed. To carry out the sector classification, the first two digits of the NACE code were used as a reference, which allowed us to have sufficient representation in 51 sector categories. The results shown in Table 6 confirm strong positive correlations for a level of significance $\alpha = 0.01$ between the proportion of companies certified in each sector and the rates of minor and serious work accidents per employee.

In the next step, the rates of accidents in certified and non-certified companies in each sector were compared in Table 7. For the case of minor accidents, there are statistical differences in three sectors: "Chemical industry," "Other industries," and "Building." In those three cases, the certified and bigger companies have fewer accidents than non-certified companies (Table 7). For serious accidents, the "Building" sector is the only one that is significantly different. The certified companies have fewer accidents and are also bigger on average. For fatal accidents, for the sector "Extractive and Manufacturing industries" the certified companies are bigger size and have more fatal accidents.

4.2. Linear regression model

Finally, a linear regression model was developed to analyze in greater depth how the variables are associated with the rate of work accidents per 1000 employees. In the first step, the OHSAS 18001 certification is introduced as a dummy variable. In the second step, the main general categories for the sectoral breakdown are introduced (Industry, Building, and Services). And in the third and last step, the size of the companies (logarithm of the number of employees) is inserted. It is observed that, with only the OHSAS 18001 certification variable, the model is only significant for the case of fatal accidents (Table 8). R^2 values are very low, explaining 0.1% of the variance or less. By including the sector variables the model is significant for the case of minor and serious accidents for $\alpha = 0.01$ but the explained variance remains very low 4.6% and 0.3% for minor and serious accidents, respectively. Finally, when

Table 7
Relationship between OHSAS 18001 certification and the average number of accidents broken down by sector for certified and non-certified organizations.

	Size log employees		Accidents per 1000 employees					
			Minor		Serious		Fatal	
	OHSAS	OHSAS	OHSAS	OHSAS	OHSAS	OHSAS	OHSAS	OHSAS
	Yes	No	Yes	No	Yes	No	Yes	No
Agriculture, cattle ind., fish	1.613[b]	1.428[b]	77.955	76.578	1.175	0.583	0.000	0.181
Extract. and manufact. Indust.	1.572[b]	1.397[b]	95.718	64.099	2.120	0.936	2.071[b]	0.034[b]
Chemical industry	1.951[a]	1.559[a]	42.206[b]	76.611[b]	2.166	0.878	0.009	0.000
Metal	1.907[a]	1.554[a]	101.691	119.593	0.923	3.964	0.436	0.127
Other Industries	1.715[a]	1.426[a]	43.982[a]	83.353[a]	0.295	0.831	0.669	0.000
Building	1.574[a]	1.345[a]	104.631[b]	185.645[b]	0.640[b]	5.333[b]	0.255	0.018
Trade, hospitality	1.810[a]	1.497[a]	21.519	30.934	0.679	0.274	0.000	0.000
Transport., communications	1.9247	1.7664	43.681	49.511	0.479	0.357	0.107	0.044
Finance, estate agencies	2.253[a]	1.755[a]	25.351	28.947	0.386	0.908	0.000	0.121
Public admin. and education	1.780	1.263	18.306	18.298	0.075	0.211	0.000	0.028
Health & vet. & social services	1.613[b]	1.428[b]	33.101	39.932	0.663	2.040	0.006	0.000
Other social & personal activities	1.572[b]	1.397[b]	34.637	30.701	0.242	0.047	0.013	0.000
F	13.324	7.483	10.536	17.649	1.176	2.346	0.854	0.985
Significance	0.000	0.000	0.000	0.000	0.295	0.005	0.595	0.461

The estimator F of population variance has been calculated to measure the significance of the difference of proportions and means according to the firm sector.
The Mann–Whitney U test has been applied to analyze the difference in means between certified and no certified companies.
[a] Significant differences for a significance level $\alpha = 0.01$ applying the Mann–Whitney U two-tailed test.
[b] Significant differences for a significance level $\alpha = 0.05$ applying the Mann–Whitney U two-tailed test.

Table 8
Summary of the linear regression model for accident prediction.

Step	Accidents per 1000 employees								
	Minor			Serious			Fatal		
	R^2	F	Sig.	R^2	F	Sig.	R^2	F	Sig.
1	0.001	2.824	0.093	0.000	1.398	0.237	0.001	4.680	0.031
2	0.046	61.722	0.000	0.003	4.447	0.001	0.001	1.279	0.276
3	0.048	52.267	0.000	0.003	3.584	0.003	0.002	1.993	0.076

Table 9
Coefficients of the linear regression model for accident prediction.

Step		Accidents per 1000 employees					
		Minor		Serious		Fatal	
		Stand. beta	Sig.	Stand. beta	Sig.	Stand. beta	Sig.
1	OHSAS 18001	−0.023	0.093	−0.016	0.237	0.030*	0.031
2	OHSAS 18001	−0.035*	0.010	−0.020	0.154	0.030*	0.031
	Industry	0.013	0.631	0.026	0.335	0.011	0.685
	Building	0.119**	0.000	0.049*	0.011	−0.002	0.928
	Services	−0.138**	0.000	−0.007	0.795	0.005	0.868
3	OHSAS 18001	−0.028*	0.038	−0.019	0.172	0.034*	0.015
	Industry	0.015	0.571	0.027	0.331	0.013	0.648
	Building	0.118**	0.000	0.049*	0.012	−0.002	0.907
	Services	−0.130**	0.000	−0.007	0.817	0.009	0.742
	Size	−0.051**	0.000	−0.005	0.715	−0.031	0.028

Table 10
Correlation indices between sector variables and size.

	Industry	Building	Service
Size	−0.057**	−0.066**	0.070**

size is introduced, the model continues being significant for $\alpha = 0.01$ for minor and serious accidents, but the explained variance remains very low. The full model accounts for only 4.8% of the variance in the case of minor accidents and only 0.3% for serious accidents. For the case of fatal accidents, the model is only significant for the first step, when OHSAS 18001 certification is introduced alone as a dummy variable.

For minor accidents, the variable OHSAS 18001 certification is negative and significant in the second and the third step for $\alpha = 0.01$ and 0.05, respectively, but its influence is smaller than the sector and size (Table 9). Belonging to the Building sector has a significant and positive influence in the rate of minor and serious accidents, while belonging to the sector of Services (a category that includes the subsectors of Public administration and education, Health and veterinary activities and social services, and Other social and personal activities) has a negative influence on the rate of minor accidents. The influence of size is also negative, confirming the results obtained in the descriptive analysis. Size is correlated with the sector distribution for $\alpha = 0.01$ (Table 10).

However, if we analyze the rate of fatal accidents, the influence of OHSAS 18001 certification is positive in the first step for $\alpha = 0.05$. In the second and third steps the models are not significant.

5. Discussions and conclusions

The first hypothesis, that OHSAS 18001 certification is associated with better occupational safety performance (i.e., better outcomes in terms of occupational accidents) is not completely confirmed. OHSAS 18001 certified companies tend to have a better OH&S performance in terms of minor and serious work accidents in some sectors and in the global regression this term is negative and significant. However, the variance explained by the regression model and the β coefficient of the influence of OHSAS certification are very low, and in the sectors where there are significant differences, the certified companies are bigger, a feature that is negatively correlated with the rates of minor and serious accidents at work. In addition, it was found that for fatal accidents the certified companies have more accidents, and in the regression model there is a positive significant β coefficient. Hypothesis 2 states that OHSAS 18001 is more likely to be adopted in economic sectors of activity with worse OH&S performance (i.e., worse outcomes in terms of work accidents). That it is statistically indistinguishable from hypothesis was partially supported. The distribution of OHSAS is not homogeneous and the percentage of companies certified according to OHSAS 18001 in a certain sector is positively and strongly correlated with the number of minor and serious accidents. This finding points to a possible selection effect, whereby more accident prone sectors have a greater tendency toward certification. However, the correlation index for fatal accidents is not significant and negative.

Generally speaking, the results of this study confirm the legitimacy theory account of the implementation of certifiable management standards (Boiral, 2012; Christmann & Taylor, 2006; Heras-Saizarbitoria et al., 2013). This theory states that companies with higher rates of accidents per employee at work are more likely to adopt the OHSAS 18001 standard. This reflects the search for social legitimacy by organizations exposed to higher risks. Those risks increase the institutional pressures to adopt recognized reference standards for SMSs such as OHSAS 18001. Similarly, the lack of connection between the adoption of this standard and accident reduction might reflect the lack of internalization of OHSAS 18001. In many organizations, the implementation of this standard could be mostly symbolic rather than substantial. As a result, the standard might be used as a legitimation tool intended to improve the corporate image rather than as an effective OH&S management tool, substantially internalized in organizations and likely to reduce work accidents. The implementation of the OHSAS 18001 standard, which implies significant paperwork, may also reflect a tendency to bureaucratize OH&S (Dekker, 2014) and focus on procedures rather than actual improvement of practices.

The main finding of the study also suggests the need for greater caution when interpreting the findings of earlier scholarly works that analyze the impact of OHSAS 18001 on the substantive OH&S performance indicators of certified companies. Among many other issues, the selection and treatment aspects of the adoption of this standard should be more carefully considered. Scholars should be cautious with the interpretation of the outcomes of their studies and should give greater emphasis to their limitations. This also applies to the use of performance measures whose relevance is questionable, such as profitability, which may attract undue attention because of the precedents provided by previous studies of ISO 9001 and ISO 14001 and the availability of this type of data in commercial databases (such as Amadeus by Bureau van Dijk).

This call for caution is perhaps more important now, as the new ISO 45001 standard for OH&S will be launched in 2018 (Heras-Saizarbitoria et al., 2017). As happened in the launching and restyling stages of both ISO 9001 and ISO 14001, this is a fertile period for perverse and deterministic interpretations of the results of scholarly studies, which suit the commercial purposes of a set of stakeholders, including certain certification bodies and auditors (LRQA, 1996; BAB, 2011). Certification bodies and the appropriate national and international associations for standardization should ensure that need for caution is widely understood, as the prevailing opinion is that the rigor and effectiveness of the certification process of the main certifiable management standards are questionable (Heras-Saizarbitoria et al., 2013), as external audits are often ambiguous and unreliable.

The level of internalization of this type of certifiable management standard should be taken into account. Many studies of ISO 9001 and ISO 14001 (Aravind & Christmann, 2011; Boiral, 2012; Heras-Saizarbitoria, 2011; Heras-Saizarbitoria & Boiral, 2015; Iatridis & Kesidou, 2018) have emphasized that the effectiveness of this type of standard largely depends on the way it is implemented, particularly in

terms of employee and manager involvement. As underlined by Fernández-Muñiz, Montes-Peón, and Vázquez-Ordás (2009, 2014); Fernández-Muñiz et al. (2012a, 2012b), OHSAS 18001 is the first step toward a systematic and successful management of OH&S activities and safety at work. High levels of management commitment and support (especially from top management) and commitment from all the employees can bring about the profound change in values and behavior that is necessary for a true work safety culture. It is a long journey, in which management system standards such as OHSAS 18001 will make a contribution only if they are correctly internalized in the day-to-day activities of organizations and are not disconnected or decoupled from them.

This study has several limitations. Although the data used for this study are extensive, obtained with a rigorous protocol, and detailed (in terms of the classification of work accidents), it has some limitations. First, as emphasized by studies of ISO 9001 (Heras et al., 2002) and ISO 14001 (Heras-Saizarbitoria, 2011), access to longitudinal data for this type of analysis is important, as there is a lag in the process of implementing the standards and obtaining the certificates. This has also been found for the case of OHSAS 18001 by Fernández-Muñiz et al. (2012b). Second, this study focused on a specific country, so the results can only be generalized to that context. The limitations of this study give rise to a series of suggestions for future research. The *negative* selection-effect of the main international management standard for OH&S examined in this study should be analyzed in more depth with longitudinal data, which would make it possible to distinguish clearly between the effects of selection on observables and post-adoption divergence in trends. To that end, collaboration between scholars and private and public practitioners and public decision makers in the field and other stakeholders and institutions, such as foundations that foster safety at work and trade unions, is essential. Similarly, collecting data from diverse regions of the world would allow researchers to generalize the results further, and to secure this outcome future work should involve the collaboration of researchers from different parts of the world.

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