Perception of risk in construction. Exploring the factors that influence experts in occupational health and safety

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ABSTRACT

Risk perception is studied in many research disciplines. Although many of the factors that influence the perception of risk in the field of occupational risk prevention are known, there is still no complete understanding of the ways in which professionals in this sector perceive risks. This study analyzes the incidence of sociodemographic variables (gender, age, university degree, seniority of the qualification and professional experience) in the perception of the probability and consequences of accident risk of a group of Construction Safety and Health Experts. Additionally, the incidence of these variables has been evaluated in various stages of a construction. On the basis of a questionnaire survey of 30 construction processes, and applying a linear multilevel regression model, statistically significant differences in perceived risk were obtained depending on the age of the Construction Safety Experts, while it was determined that there is no significant difference in the perception of risk between men and women in this professional sector. Greater discrepancies were found when evaluating the overall risk of construction activities in the early stages of a construction site. Nevertheless, in spite of the sociodemographic differences between Construction Safety Experts, we conclude that their risk assessments are highly coherent.

1. Introduction

Globally and more specifically in Europe, the construction sector is identified with the highest rates of workplace accidents. Concern about this fact, the rate of occupational accidents on construction sites, has led to the adoption of numerous agreements at European level, highlighting the seriousness of the problem.

One of the most important agreements adopted led to the approval of the Council Directive 92/57/EEC of 24 June 1992 on the implementation of minimum safety and health requirements at temporary or mobile construction sites, which had to be transferred to the legal system of its member states. This directive (92/57/EEC) is now known worldwide as the Construction Sites Directive (CSD) (Dias, 2004)

This Directive, which has among its objectives to reduce the accident rate, is the origin of the health and safety coordinator in the construction sector. The Directive has been transposed in different countries of the European Union. In all of them, the concurrence with the Directive in its fundamental aspects is nearly complete. In Spain, the appearance of the coordinator in the field of health and safety in construction works, as a necessary and competent technician, occurred in the last days of 1997. It was the beginning of a new professional career.

Over the past two decades, concerns have been raised about accreditation, training, competence, performance, etc. These professionals have been controversial figures, however, there is an agreement that this professional is a key player in the prevention and reduction of accidents in the construction sector.

Meanwhile, injury rates and associated costs in the construction industry continue to be higher than average (Dong et al., 2007). Construction continues to be very dangerous despite the fact that there are resources (statistics, causal factors, and control measures to reduce risk) that health and safety professionals in the sector are aware of (Zalk et al., 2011). Even after the implementation of strict laws and regulations (Dulaimi and Chin, 2009), this is still true.

The birth and the advance of the time of the coordinators in the field of safety and health has been full of uncertain situations, controversies and modifications that have led to ups and downs in the development of their professional activity and made it a controversial professional career.

Some of the most important problems are:

- The question of who can be the coordinator in terms of health and safety on construction sites remains controversial. Originally, this

job was fulfilled by a multitude of technicians who, with different training, educational backgrounds, and competencies in the construction industry environment, took on the role of health and safety coordinators at construction sites. In the absence of specifications, subsequent regulations established the academic qualifications that allowed them to carry out the functions of coordinator in matters of health and safety, in accordance with the provisions in force for each degree, and added the recommendation of additional or complementary training for the university degree in the field of development of construction processes and prevention of specific risks at construction works. Currently, disputes about the fields of action of academic degrees have even reached the courts of law and complementary training has not consolidated their mandatory nature.

- About when the health and safety coordinator is needed in the execution stage remains debatable. The execution phase is usually the longest phase of the project and it typically consumes the most energy and the most resources. In the beginning, the promoters of construction works found in the normative texts published until 1997, several references that would leave aside the mandatory appointment of the health and safety coordinator. Again, subsequent regulations and clarifications on the broad and varied legal obligations/duties, the definition of a construction job, or the anticipated hazards during job performance have led to the fact that it is almost impossible to find a job (e.g. renovations) where the health and safety coordinator has not been assigned in the execution phase.

We can add to these factors the dependent nature of the construction industry, at international level, on economic growth and the impact of the global economic and financial crisis, with results as marked as the effect produced both by the expansionary phase of the economic cycle of the first years of the 21st century (Nistorescu and Ploscaru, 2010), followed by a subsequent economic recession with the effect of a significant deterioration in the living and working conditions of a large part of society and especially of the population linked to the construction sector (Meardi et. al., 2012; Rocha and Aragon 2012).

We must also take into account other factors, such as, the constant evolution of the constructive and preventive technique, which should allow the health and safety coordinator to look develop their professional careers in optimal conditions (Romero and Gámez, 2005), as well as age, which is a factor that affects cognitive development (Byrnes, 2010; Ogumeto 2012) and the process of insertion in the labor market (Leeson, 2006) and gender, given that women may encounter a series of obstacles due to the dominant male culture (Goldenhar and Sweeney 1996) as in the case of the construction industry.

In Spain, some territories have created a registry of health and safety coordinators. Andalusia is one of the territories that has established a Public Registry of Coordinators for Health and Safety Matters in Construction Works. The inclusion in this registry is allowed for those persons who, in accordance with current legislation, are empowered to exercise the functions of coordinator in matters of health and safety, and who can demonstrate that they have specialized preventive training, at least with the minimum content, contemplated in the technical guide for the evaluation and prevention of risks related to construction works or in accordance with an equivalent training program. Therefore, those in the public registry of Andalusian health and safety coordinators can be considered experts in prevention of occupational hazards in the construction industry.

The role of the health and safety coordinator in the execution phase can be considered the core of his/her mission, since it is in the execution phase that occupational accidents occur. The mission of the health and safety coordinator is to promote actions on working conditions, in the different phases of the works, to allow adequate planning and integration of safety, with the aim of eliminating or reducing accidents in the construction. (Pradera Diéguez, 2007). Fang, Xie, Huang and Li (Fang et al., 2004) identified 5 main factors to establish the allocation of limited health and safety resources at construction sites in China, with the participation of the occupational health and safety coordinators being the most important (Fang et al., 2004).

The objectives of the study of health and safety coordinators' risk perceptions are: (1) To compare health and safety experts' perceptions and judgments of risks at construction sites. (2) To discuss to what extent various socio-occupational conditions influence the perception and judgment of accident risk. (3) To propose measures to increase the consistency of risk assessments.

2. Brief literature review

2.1. The social construction of risk and the risk perception

Risk is above all a social representation. It appears in various forms depending on the societies, periods, social categories or gender (Urteaga and Eizagirre, 2013).

The concept of “social construction” associated with risks has shown great analytical utility, although, like other concepts that translate/interpret reality, diverse meanings have been attributed to it throughout its evolution. It has been proved through the study and revision of contents that the concept of social construction of risk is associated with the concepts of perception and vulnerability (García Acosta, 2005).

In the historical process of the social construction of risk, it is shown how the rational perception of risks is marked by the lack of information and the omission of social contexts in the definition of symbols that allow identifying the risks themselves (Fabiani, 1987).

Recognizing the contribution of Mary Douglas (Douglas and Wildavsky, 1983) in addressing social theories of risk through a cultural analysis of risk and specifying its definition based on the nature-culture relationship, one of the most relevant studies in the field of social construction of risk (Fabiani, 1987), presents a narrative of risk perception, the evolution of which is divided into three stages. In the first, which he calls the fear phase, risk perception is associated with providence, in a time prior to 1750. In a second stage, a change in risk perception occurs with the arrival of the industrial revolution. The third and last stage is that of unbearable risk. In this third stage, nuclear risk is the reference.

The arrival of social conflicts derived from the changes brought about by the technological and digital revolution continue to evolve the concept of social construction of risk and its association with prevention. For example, Beck (Beck et al., 1992) is introduced the concept of “risk society”, showing the change that occurs through technology and the productive changes in a society that gains wealth, but adds new risks that are ever increasingly difficult to perceive and with more uncertain effects. Beck and Rey (Beck and Rey, 2002), came to characterize these new risks, which present themselves to social groups as uncontrollable, incalculable, unpredictable and irreversible. Luhmann (Luhmann, 2007) stated that under current world conditions there is nothing to do but venture and take risks.

We see that social construction of risk evolves over time, but it also evolves with social groups and depending on each territory. The concept of risk is addressed in all sectors, from the environment to finance, from engineering to health and many others, and its importance is relevant in all fields (Althaus, 2005).

Nowadays its meaning, in developed countries and in the industrial sector, has a specific characterization. The risk due to human activity is no longer a fatality. It is an act of responsibility and has become the subject to numerous controversies surrounding its identification and the ways to prevent it (Urteaga and Eizagirre, 2011). The specific way in which societies and their members handle different risks has to do with the type of risk they face (Fragouli and Theodoulou, 2015).

As a rule, organizations manage the risk by identifying it, analyzing it and then evaluating whether the risk should be corrected to meet its international risk criteria (International Organization for Standardization, 2009).

The advancement of scientific, technical and engineering

capabilities should lead to constant improvements in our ability to control, reduce or eliminate risks (Covello and Mumpower, 1985).

We must emphasize here that the cultural dimension of risk is always an elaboration on concrete risk situations, against which particular individuals are forced to take a position. The construction of the specific symbolic meaning that the different social subjects attribute to risk, and especially their positioning and the actions that they develop against it, are related both to the perception of risk and to a broader set of sociocultural mediations. Among these, the skills and competencies they possess as workers can be highlighted (Salas, 2003).

The perception of risk is therefore a social process and in itself a cultural construction (García Acosta, 2005).

Theoretical reviews on the study of risk perception show that this construct can be approached from several perspectives. In our case, treating the perception of health and safety risks, the structural perspective seems the most appropriate, since it focuses on the perception of the risk associated with real situations.

Starting with this approach Slovic, Fischhoff and Lichtenstein (Slovic, et al., 1982) sought to:

• discover what citizens consider risks and why,

• develop a theory of risk perception by which you can predict your responses to new risks and

• develop techniques to assess the complex and subtle opinions that people have about risk.

The perception of risk is a phenomenon in search of an explanation (Sjöberg, 2000, Hawkes and Rowe, 2008, Bonem et al., 2015). The perception of risk has advanced from being considered a product of the population's lack of awareness to becoming a complex problem and one which is studied by a large number of professionals from varied disciplines such as psychology, sociology or engineering (López and Reyes, 1999).

The data provided by the research group led by Paul Slovic illustrates different points of disagreement between risk assessment experts and non-experts (Slovic, 2000). The exploration of differences in perception between experts and non-experts in judgments of probability and / or magnitude of perceived risk in different sources of danger is accompanied by another debate on the controversy between perceived or subjective risk and objective or real risk (Slovic et al., 1980; Lichtenstein et al., 1978). The perception of risk among experts is also modulated by personal and social factors. Experts demonstrate bias in their choices of theories, methods and data, and often groups of experts differ among themselves (Kasperson et al., 1988; Morgan et al., 2019).

On how construction workers perceive risks, the different perceptions of risks and their acceptability, between workers and management, have been highlighted (Hallowell, 2010). Differences in attitudes and perceptions have also been identified among workers with different jobs (Findley et al., 2007). We are confident that much remains to be done to contribute to the understanding of risk perceptions in the construction industry.

2.2. Risk assessment

As a general rule, effective risk management requires evaluating its impact to keep it under control. Risk assessment has become a true industry that involves a complex and controversial process (Nelkin, 1989).

Risk assessment methods have been used for decades, both due to legislative obligations and for technical reasons (Rubio Romero, 2004). Each discipline has generated literature on risk assessment methods, and seeking to be effective in one area of application, these have been specialized and fragmented (Covello and Merkhoher, 2013).

A risk assessment requires drawing conclusions and making decisions (Zhou et al., 2015). Risk assessment is substantially subjective and represents a mixture of science and judgment with important psychological, social, cultural and political factors (Slovic, 1998). Experts do not escape these determinations because their determinations are embedded in social ties (Urteaga and Eizagirre, 2013).

Achieving an adequate level of safety depends on how risks are assessed and coherence when making decisions to reduce and control them (Cagno et al., 2000).

Effective management of occupational health and safety risks can be substantially hindered when decision-makers significantly differ in their understanding of the nature of a hazard (Zhao et al., 2016). Thus, effective decisions are based on the analysis of data and verifiable information, in this way all the people involved understand the way in which decisions are made.

In the field of occupational risk assessment, there are opposing positions, and at one of the extremes are those who believe that, given a source of risk, there is an objective level of risk that can be calculated, a measure of actual risk. It has been decades since any scientist defended this unrealistic point of view (Vidal and Gómez, 2001).

The criterion of the person making the evaluation is a determining factor in its result. In fact, risk assessments necessarily depend on human judgment (Hurst, 2007). Certainly, much of the credibility and acceptance of results depends on the people who carry out the risk assessment (Fung et al., 2012). It is very important that results obtained in risk assessments are reliable so that they are accepted as valid by all parties involved (Eliasson et al., 2017, Grill and Nielsen, 2019). If the parties involved at the time of making a decision have no objections to the model used, the data, the judgments of the experts and the deductions made, then the risk assessment can be considered good enough (Rosqvist, 2010). This is facilitated by an effective cooperation between employers and workers (Niskanen et al., 2012).

The “construction” working group of the National Commission for Health and Safety at Work of Spain (CNSST) has shown that in construction projects it is difficult to carry out a risk assessment for each job, given the characteristics of mobility, changing environment and diversity of tasks (Santiago, 2010). In this sense, each company participating in the project must carry out an initial evaluation based on the activities and trade that it develops, determining the preventive measures that it will apply to control the risks identified in each one of them. These measures then serve as the basis for establishing the work procedures that the company will implement. The repercussions of deficiencies in risk assessment in the construction sector are serious, especially for qualified construction workers and laborers (Cantalejo et al., 2005).

Although several traditional methods exist to address occupational risk assessment in the construction industry (Jannadi and Almishari, 2003, Pinto et al., 2011), the assessment criteria used in the method of risk assessment in the study are in accordance with the criteria established by the European Commission in its document “Guidance on risk assessment at work”, and with the criteria established by INSHT (National Institute for Safety and Hygiene at Work). The risk of an accident is determined by two key concepts: the harm it can cause and the probability of materializing. Both concepts are difficult to assess accurately (INSHT, 2011). We have focused on the assessment of “objective” risks (Arezes and Miguel, 2008), using the qualitative risk analysis in the workplace.

The current regulations in the construction industry determine that the employer must plan preventive actions, previously evaluating the risks, depending on the resources, procedures and work methods. At construction sites, the risk assessment is a critical activity that should be reviewed, therefore it should be an ongoing process. (Romero and Gámez, 2005).

The study explores the judgment made by experts when they are asked to assess certain conditions or dangerous situations. It involves identifying, to the extent possible, the deviations between expert evaluations with respect to the score of the probability of an accident and the consequence of each activity at risk. Understanding how risk perception affects risk assessment could become a valuable component in risk management strategies (Lu and Yan, 2013).

The hypotheses of the risk perception study of the health and safety

Fig. 1. Summary of the research methodology.

coordinators are: (1) The coordinators for safety and health matters, as their age increases, will perceive a greater probability of accident risk, a greater severity of its consequences and, therefore, their risk assessment will be higher (2) The coordinators for safety and health matters who have completed different university studies will perceive a probability of an accident risk, a severity of its consequences and, therefore, will have a different evaluation (3) The coordinators for safety and health matters, as their work experience increases, will perceive a lower probability of accident risk, a lesser severity of its consequences and, therefore, their risk assessment will be lower.

3. Methods and materials

The methodology adopted to find coherencies and discrepancies in the perception of risk has consisted in the construction of a questionnaire for data collection and a subsequent statistical analysis, applying a multilevel model of the information collected. An outline of the steps followed in this research is shown in Fig. 1.

Our research is based on the line established by other researchers (Zhao et al., 2016, Zhang et al., 2013) aimed at evaluating the subjectivity involved in situations that the individual faces in his daily life, in the social environment with which he interacts, by using photographs as stimuli, with a selection of people with particular interests and identified by attitudes about risk perceptions in occupational health and safety. It was decided to use a survey to collect data, as it is the most commonly used method for detecting intergroup discrepancies (O'Toole, 2002).

When designing the questionnaire, we took into account the division into phases of a construction used to code the accidents investigated by the Labor Authority in Andalusia.

An online questionnaire was designed to measure the estimation of the probability and the consequences of an accident by coordinators for health and safety matters at construction works to facilitate participation. The questionnaire was developed using the online survey application "LimeSurvey". The survey was anonymous.

The questionnaire comprised three parts: a first block of instructions, a second block with socio-occupational variables and a final block

Table 1
Socio-occupational variables and their categories.

Gender (control var.)	Male Female
Age	Under 35 years Between 35 and 45 years Between 45 and 55 years Over 55 years
University studies	Arquitecto técnico (1) Arquitecto (2) Ingeniero técnico (3) Ingeniero (4)
N° of years qualification held (control var.)	Less than 10 years Between 10 and 15 years More than 15 years
Experience in health and safety coordination	Fewer than 10 works Between 10 and 25 works More than 25 works

(1) Arquitecto Técnico, this qualification is equivalent to a Bachelor in Architectural Technology which is classified as level 6 in the International Standard Classification of Education (ISCED) 2011 levels of education and in the European Qualifications Framework (EQF)
(2) Arquitecto, this qualification is equivalent to a Master's in Arquitecture, which is classified as level 7 in the International Standard Classification of Education (ISCED) 2011 levels of education and in the European Qualifications Framework (EQF)
(3) Ingeniero Técnico, this qualification is equivalent to a Bachelor in Engineering which is classified as level 6 in the International Standard Classification of Education (ISCED) 2011 levels of education and in the European Qualifications Framework (EQF)
(4) Ingeniero, this qualification is equivalent to a Master's in Engineering, which is classified as level 7 in the International Standard Classification of Education (ISCED) 2011 levels of education and in the European Qualifications Framework (EQF)

where photographic images of construction processes were shown and the possible values of their probability and consequence assessments with respect to the occurrence of an accident for each of the dangerous situations.

The socio-occupational variables, analyzed are shown in Table 1. The variables probability and consequences and the combination of both (risk level) constitute, in our study, the dependent variables.

Each screen of the questionnaire asked the professional surveyed to estimate, by means of a 5-level Likert scale, the probability of the occurrence of an accident at work (1 = hardly ever, 2 = rarely, 3 = sometimes, 4 = many times, and 5 = almost always) and the seriousness of the consequences expected in the case of the accident occurring (1 = very minor, 2 = minor, 3 = moderate, 4 = serious, and 5 = very serious). One of these screens can be seen in Fig. 2. The use of photography as a research tool of the exploratory type has helped generate satisfactory results in previous research (Banks, 2008). Five levels were chosen to allow easy differentiation between different situations so as to avoid it becoming difficult to position a situation at one level or another. The matrix of risk level resulting from the product (probability × consequence) can be seen in Fig. 3.

According to accident statistics investigated in Andalusia, the six phases of a construction with the highest percentage of accidents were: Structure, Facade, Roofing, Partition, Installations and Finishes (Carrillo-Castrillo et al., 2017). Each page of the questionnaire was dedicated to each of these six phases. Each screen of the questionnaire showed five usual or standard work methods to assess the potential for individual accidents. Altogether, thirty construction activities were covered in the survey. The distribution of phases and tasks can be seen in Table 2. Although each construction project as a whole is unique, individual construction activities and methods are fairly well-defined and known (Rozenfeld et al., 2010). The selection of construction activities and photographs were taken from the documentation areas of public bodies related to the prevention of occupational hazards. The final selection of tasks was done through a review carried out by four

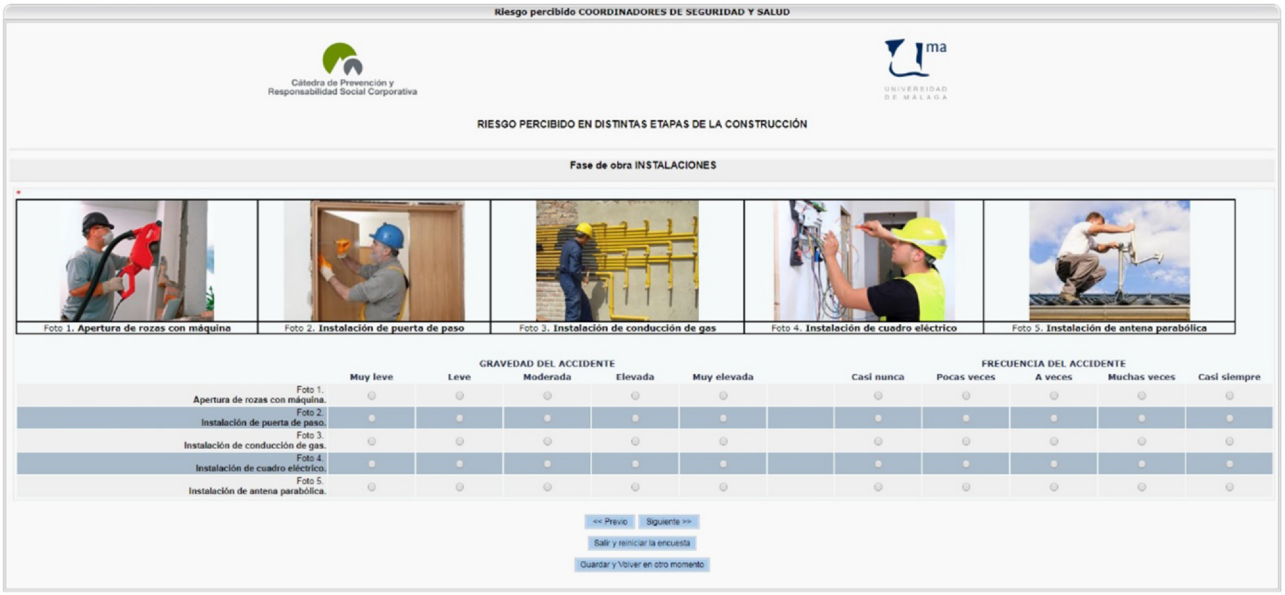

Fig. 2. Sample of the questionnaire.

experts in the field of health and safety (two university professors and two competent technicians with more than 15 years of experience) of an initial draft. It was decided to discard the less common working methods and two iterations of task reviews were performed. Once the tasks had been chosen, it was decided to replace the images that generated doubts. The third version of the proposed questionnaire was accepted.

The selection of participants for the completion of the questionnaire was done through the Public Registry of Coordinators for Health and Safety Matters at Construction Works, which was created by the Andalusia government in 2005 in accordance with Decree 166/2005. The use of this registry furnished us with the possible participation of more than 700 construction safety experts. The invitation to participate was disseminated through emails. Any questions were answered by the authors by means of a specific email address (Table 3).

For the analysis we used a linear regression model. Multilevel linear regression analysis is the most effective approach to modeling given the nature of the data used, with evaluations nested within experts. This structure prevents observations from being considered strictly independently from each other. In this way, standard errors are not underestimated due to intra expert correlations and second level variables are allowed as predictors in the models, in order to check for explanations at the expert-level variability (Snijders and Bosker, 2011). This methodological approach has already proved to be useful in related areas, such as in the study of severity, number of compliance orders issued and time to achieved compliance of working place inspection outcomes, with inspection episodes nested within safety inspectors (Burstyn et al. 2010), in the analysis of various micro–macro organizational factors on workgroup's safety initiatives with workgroups nested in plants of the manufacturing industries (Simard and Marchand 1995), or in the prediction of individual perception of injury risk according to work shift of employees nested within companies (Huang et al. 2007).

Consequently, we proposed three multivariate models of two levels. As the values of the dependent variables, probability and severity, ranged between 1 and 5, and the variable that included both parameters in a single evaluation varied from 1 to 25, we chose to apply a linear multilevel regression model, with random intercepts. We included dummy variables for the construction phase in this model, rather than extending the model to another level for 'phase', since there are only six phases in total. All the other explanatory variables were second level variables referred to by the expert. Maximum likelihood estimation was used to fit the model using Stata 14 (command xtmixed). The effect of non-normal residuals at the second level of the models on the parameter estimates is little or negligible (Maas and Hox, 2004). The model for the experts' assessment can be summarized as:

where β_0 is the overall mean across experts, u_{0j} is the effect of expert j on assessment and $e_{ij,}$ is a photograph-level residual. u_{0j} is assumed to follow a normal distribution with mean zero and variance σ^2_{u0}.

Probability	Almost always	5	10	15	20	25
	Many times	4	8	12	16	20
	Sometimes	3	6	9	12	15
	Rarely	2	4	6	8	10
	Hardly ever	1	2	3	4	5
		Very minor	Minor	Moderate	Serious	Very serious
		Consequence				

Fig. 3. Risk level matrix.

Table 2
List of construction activities.

Construction phase STRUCTURES	Construction phase PARTITION WALLS
Photo 1. Assembly of armatures.	Photo 1. Plastering of wall with mortar.
Photo 2. Installation of slab.	Photo 2. Partition wall using plasterboard panels.
Photo 3. Pillar formation.	Photo 3. Partition wall using solid brick.
Photo 4. Concrete pouring.	Photo 4. Preparation of mortar with manual concrete mixer.
Photo 5. Metal structure assembly.	Photo 5. Partitioning with plaster.
Construction phase FACADES	Construction phase INSTALLATIONS
Photo 1. Installation of glass facade.	Photo 1. Creation of channels by machine.
Photo 2. Vertical work on the facade.	Photo 2. Installation of interior door.
Photo 3. Placement of prefabricated walls.	Photo 3. Installation of gas supply.
Photo 4. Renovation of facade.	Photo 4. Installation of electrical panel or fuse box.
Photo 5. Assembly of elements from platform.	Photo 5. Installation of satellite dish.
Construction phase ROOFING	Construction phase FINISHES
Photo 1. Lifting of panels.	Photo 1. Cleaning of glass railing or balustrade.
Photo 2. Dismantling of existing covering.	Photo 2. Floor polishing by machine.
Photo 3. Concrete pouring.	Photo 3. Painting of garage.
Photo 4. Fixing of tiles.	Photo 4. Exterior painting.
Photo 5. Installation of metal roof covering.	Photo 5. Removal of waste materials.

Table 3
Participant summary.

Gender	Count	Percentage
Male	67	81,71%
Female	15	18,29%
	82	100,00%
Age	Count	Percentage
Over 55 years	11	13,41%
Between 45 and 55 years	21	25,61%
Between 35 and 45 years	39	47,56%
Under 35 years	11	13,41%
	82	100,00%
University studies	Count	Percentage
Arquitecto técnico	41	50,00%
Arquitecto	10	12,20%
Ingeniero técnico	21	25,61%
Ingeniero	10	12,20%
	82	100,00%
N° of years qualification held	Count	Percentage
Less than 10 years	34	41,46%
Between 10 and 15 years	22	26,83%
More than 15 years	26	31,71%
	82	100,00%
Experience in health and safety coordination	Count	Percentage
Fewer than 10 works	37	45,12%
Between 10 and 25 works	24	29,27%
More than 25 works	21	25,61%
	82	100,00%

3.1. Distribution of the sample

Below are the descriptive results of the participants in the study. The mail servers rejected several addresses of the initial 759, leaving a final dissemination of 608 invitations. The number of responses received in the two months that the questionnaire reception period was open was 121. The success rate of the questionnaires received was 67,77%, since 39 were discarded as incomplete. Finally, the study was carried out with 82 questionnaires. For multilevel regression models, it has been proved that the estimates of the regression coefficients, the variance components, and the standard errors can be considered unbiased and accurate, as the sample size at level two is larger than 50 (Maas and Hox, 2005).

Of the 82 responses, 81,71% were male (n = 67) and only 18,29% were female (n = 15). This data of gender distribution in the study is notable, as it shows a high percentage difference between men and women. However, our values are in line with female participation in the construction sector in Spain, which was established at 9,07% of administrative jobs (Infante et al., 2012), with the percentage of women being significantly lower in the sector overall. Another proof of the correction of this ratio is its consistency with the data offered by the National Institute of Statistics (INE), which indicates that in Spain in 2015, the construction sector was one of those that recorded the lowest rates of women workers. Additionally, the Conference of Rectors of Spanish Universities (CRUE) in its annual report "The Spanish university in figures" for that year 2015, placed the percentage of women who graduate in higher education in the fields of mechanics, electronics and other technical qualifications; industry and construction at 4.1%. This fact perpetuates the role of a works health and safety coordinator as being principally undertaken by men with women being clearly underrepresented.

The other obvious value among the available options is the percentage of arquitectos técnicos who act as coordinators for health and safety matters at construction works compared to other possible university degrees. Of the 82 participants, 50,00% were arquitectos técnicos (n = 41). The professional associations of arquitectos técnicos state that the majority of the "coordinators for health and safety matters at construction works" working in construction works in Spain are surveyors and / or technical architects, an affirmation that is in line with this study.

4. Results

4.1. Reliability test

Table 4 shows the results of reliability tests performed on the questionnaire using Cronbach's Alpha. In general, the results of the Cronbach's alpha test suggest some individual bias due to his/her culture's sense of risk.

5. 2. Results of the initial analysis

The main purpose of this study was to evaluate the effects of a set of socio-occupational variables, especially age, university degree and professional experience, in perception on the perception that experts

Table 4
Results of the Cronbach's alpha test of reliability.

	Likelihood		Severity	
	Cronbach's alpha	N° of photos	Cronbach's alpha	N° of photos
Construction work	0,957	30	0,926	30

Table 5
Exploratory results.

			Likelihood	Severity
Gender		Count	Average	Average
	Male	67	2,74	3,24
	Female	15	2,85	3,23
		82	2,76	3,28
Age		Count	Average	Average
	Over 55 years	11	2,33	3,04
	Between 45 and 55 years	21	2,94	3,41
	Between 35 and 45 years	39	2,72	3,36
	Under 35 years	11	2,96	3,00
		82	2,76	3,28
University studies	Count	Average	Average	
	Arquitecto técnico	41	2,81	3,42
	Arquitecto	10	2,85	3,09
	Ingeniero técnico	21	2,76	3,23
	Ingeniero	10	2,46	2,99
		82	2,76	3,28
N° of years qualification held	Count	Average	Average	
	Less than 10 years	34	2,79	3,18
	Between 10 and 15 years	22	2,55	3,2
	More than 15 years	26	2,89	3,48
		82	2,76	3,28
Experience in health and safety coordination	Count	Average	Average	
	Fewer than 10 works	37	2,62	3,29
	Between 10 and 25 works	24	2,87	3,28
	More than 25 works	21	2,88	3,27
		82	2,76	3,28

have of the probability of an accident and its potential severity in a construction site. The findings show various effects that we have to expose and discuss (Table 5).

The first statistical method proposed was the analysis of variance (ANOVA) to test the differences in risk perception and level among the socio-occupational factors. Carrying out this analysis produced the following significant results (Table 6):

After the results obtained by the ANOVA analysis and considering the structure of the data handled in this study with nested observations within experts, we consider that multilevel linear regression analysis is the most effective approach to model.

6. 3. Results of the multilevel analysis

Table 7 shows several significant and non-significant values that are worth noting. In the first place, when analyzing the behavior in function of the gender variable, the results did not identify any significant discrepancy with any of the dependent variables. The results show that women and men perceive the probability of harm for the construction processes in an almost identical manner (Coef = -0,003, p = 0.987), while perceiving the severity of this harm in a similar way (Coef = 0,021, p = 0,895).

Unlike the case of gender, the results show that the age variable does have a statistically significant association with both the level of perceived risk and with its two components; consequences and, especially, likelihood. The results show that construction safety experts of intermediate ages, between 35 and 55 years, perceive the probability and the consequences of harm in construction processes in a very similar way, their coefficients are very close and their meanings are very high in both parameters. The case of the youngest experts only shows significance in the perception of the probability of harm in the construction processes (Coef = 0.743, p = 0.023) highlighting the linearity of this parameter that decreases with age, while the experts of older and younger ages perceive the severity of this harm almost identically. In other words, the estimated score for the likelihood that experts under 35 years of age compared to the estimated score for those over 55 years of age (reference category) is that this perception increases by 0.743 points (on a scale of 5), keeping the rest of the independent variables constant.

Regarding the results exhibited by the qualifications that allow one to undertake the function of health and safety coordinator in building works, (architect or engineer) there is only significance in the engineer's opinion about the risk assessment (Coef. = -2,312, p = 0,020) and on the perception of the severity of the consequences (Coef. = -0.426, p = 0.010). This group underestimates the level, the probability of accident occurrence and the possible consequences of a risk situation

Table 6
Results of the ANOVA analysis.

	Sum of squares	gl	Mean Square	F	Sig.	
Variable: N° of years qualification held						
Risk level	Between groups	1664,441	2	832,220	3,496	,035
	Within groups	18805,398	79	238,043		
	Total	20469,839	81			
Variable: N° of years qualification held						
Severity	Between groups	2,104	3	,701	2,737	,049
	Within groups	19,982	78	,256		
	Total	22,086	81			
Variable: Age						
Severity	Between groups	2,118	3	,706	2,757	,048
	Within groups	19,969	78	,256		
	Total	22,086	81			

Table 7
Results of the multilevel analysis.

Dependent variables		Likelihood Coefficient	(model 1) P > |z|	Severity Coefficient	(model 2) P > |z|	Risk level Coefficient	(model 3) P > |z|
Gender							
	Male						
	Female	−0,003	0,987	−0,021	0,895	−0,006	0,995
Age							
	Over 55 years						
	Between 45 and 55 years	0,628	0,005	0,341	0,046	2,797	0,007
	Between 35 and 45 years	0,705	0,004	0,441	0,017	3,353	0,003
	Under 35 years	0,743	0,023	0,010	0,966	2,109	0,157
University studies							
	Arquitecto técnico						
	Arquitecto	0,187	0,505	−0,088	0,677	0,190	0,882
	Ingeniero técnico	0,071	0,702	−0,129	0,360	−0,050	0,953
	Ingeniero	−0,330	0,130	−0,426	0,010	−2,312	0,020
N° of years qualification held							
	Less than 10 years						
	Between 10 and 15 years	−0,472	0,022	−0,173	0,265	−2,283	0,015
	More than 15 years	0,090	0,668	0,236	0,137	1,071	0,262
Experience in health and safety coordination							
	Fewer than 10 works						
	Between 10 and 25 works	0,422	0,014	−0,073	0,576	0,941	0,229
	More than 25 works	0,434	0,022	−0,067	0,639	1,110	0,198
Construction phase							
	Structures						
	Facades	−0,239	0,000	0,507	0,000	0,444	0,131
	Roofing	0,017	0,760	0,659	0,000	2,034	0,000
	Partition walls	−0,807	0,000	−1,302	0,000	−5,946	0,000
	Installations	−0,649	0,000	−0,424	0,000	−3,134	0,000
	Finishes	−0,959	0,000	−0,990	0,000	−5,476	0,000
cons		2,467	0.000	3,364	0.000	9,044	0.000
Snijders/Bosker R-squared Level 1	0,209	0,375	0,323				
Snijders/Bosker R-squared Level 2	0,236	0,241	0,252				
		Coef. (*b*)	Std. error	Coef. (*b*)	Std. error	Coef. (*b*)	Std. error
	$\hat{\sigma}^2_{u0}$	0,335	0,056	0,178	0,032	6,831	1,159
	$\hat{\sigma}^2_e$	0,641	0,019	0,806	0,023	17,675	0,513
	n	2460	2460	2460			

The between-expert (level 2) variance in assessment, for the empty models (not shown here), was estimated as $\hat{\sigma}^2_{u0} = 9.012$ for the risk model, $\hat{\sigma}^2_{u0} = .440$for the likelihood model and $\hat{\sigma}^2_{u0} = .224$for the severity model. The within-expert between-photograph (level 1) variances were estimated as $\hat{\sigma}^2_e = 27.190$, $\hat{\sigma}^2_e = .795$ and $\hat{\sigma}^2_e = 1.349$,respectively. Thus, the corresponding variance partition coefficients (VPC) were: 24.89% (risk level), 35.62% (likelihood) and 14.27% (severity), which indicates that the highest variation in assessment that can be attributed to differences between experts was found for the likelihood model. In all cases, however, the VPCs were relatively high.

Level 1 R-squared can be considered the contribution of the predictors to the explained variance at between-photograph. Level 2 R-squared is the proportional reduction of error for predicting a group mean. A representative group size needs to be chosen to compute this second R-squared. Since our samples are balanced (n = 30 for each expert), group size is fixed. The first one is the most important R-squared.

compared to all other categories. The result set suggests that there is a broad degree of consensus, independent of the university degree of the expert, on the perception of accident risk.

The results indicate interesting findings when examining the time elapsed from when the participants obtained the job qualification as a health and safety coordinator in construction works. In Spain there is specific training subsequent to the university degree, of a voluntary nature, to qualify as a trained coordinator. University education in the fields of architecture and engineering do not directly train students to implement prevention at construction sites (López-Arquillos et al., 2015). This factor appears to have a complex effect on the perception of probability and consequences of risk. Those coordinators who obtained the status of competent technician more than 15 years ago, perceived the highest level of risk. Those experts who qualified between 10 and 15 years ago, perceived the lowest level of risk (Coef = -2.283, p = 0.015), with a comparatively very low probability of occurrence (Coef. = -0.472, p = 0.022). The other group, those who obtained a job qualification less than 10 years ago, place the value of their perceptions somewhere between the aforementioned two. They perceived less serious values of the consequences and less likelihood of the occurrence of accidents than the senior coordinators and with higher levels of probability and severity than those who qualified between 10 and 15 years ago. This result shows that the period in which the work qualification was obtained affects the assessments made by experts in occupational health and safety (OHS) at construction sites.

If we take into account the number of projects in which the experts have participated, the results of this study show that only the probability component seems to be significantly influenced by the variable work experience. The perception of the frequency of accidents increases with experience as a health and safety coordinator, there is only a slight difference in the estimated coefficients for more than 10 projects and less than 25 (Coef = 0.422, p = 0.014), and 25 or more jobs. (Coef. = 0.434, p = 0.022). Namely, the estimated score for the likelihood by experts who have coordinated 25 or more projects compared to the estimated score for those who have coordinated fewer 10 projects (reference category) is that this perception increases by 0.434 points (on a scale of 5), keeping the rest of the independent variables constants.

With regard to the perception in relation to the different phases of the work, the results show significance in all of them. Experts perceive roofing as the work phase with the highest risk, with an accident probability similar to the structure phase, but clearly with more serious consequences in accidents (Coef. = 0.659) and a higher level of risk (Coef. = 2,034). We can highlight how the perceived level of risk in the three final phases decreases (Partition (Coef. = -5,946), Installations (Coef. = -3,134) and Finishing (Coef. = -5,476)). It is possible to

Table 8
Comparative results between phases of the construction site.

Construction phase	Structures			Facades			Roofing			Partition walls			Installations			Finishes		
	Likelihood Coef.	Severity Coef.	Risk level Coef.	Likelihood Coef.	Severity Coef.	Risk level Coef.	Likelihood Coef.	Severity Coef.	Risk level Coef.	Likelihood Coef.	Severity Coef.	Risk level Coef.	Likelihood Coef.	Severity Coef.	Risk level Coef.	Likelihood Coef.	Severity Coef.	Risk level Coef.
Gender																		
Male																		
Female	0,174	0,076	0,795	−0,257	0,163	−0,277	0,077	−0,063	0,178	0,162	−0,081	0,398	0,051	−0,170	−0,486	−0,227	−0,052	−0,643
Age																		
Over 55 years																		
Between 45 and 55 years	0,501**	0,432*	3,226**	0,755**	0,249	3,598**	0,562**	0,213	3,194**	0,637*	0,367	2,108*	0,560*	0,747**	2,914**	0,454	0,284	1,482
Between 35 and 45 years	1,034**	0,689**	5,479**	0,894**	0,569**	5,159**	0,680**	0,206	3,445**	0,606*	0,149	1,641	0,761**	0,568**	3,206**	0,553**	0,216	1,448
Under 35 years	1,046**	0,130	3,548*	1,079**	−0,048	3,883*	0,711*	−0,050	2,987	0,571	−0,136	0,660	0,813**	0,338	2,253	0,239	−0,172	−0,676
University studies																		
Arquitecto técnico																		
Arquitecto	0,079	−0,218	−0,502	−0,066	−0,132	−0,858	0,018	−0,350	−1,156	0,326	−0,152	0,970	0,372	0,310	1,686	0,392	0,011	0,998
Ingeniero técnico	0,201	−0,165	0,086	0,176	−0,228	0,119	0,090	−0,139	−0,062	0,021	−0,001	0,386	−0,301	−0,341	−1,815	−0,363	−0,568**	−2,130**
Ingeniero	−0,036	−0,389*	−1,619	−0,636**	−0,346	−3,883**	−0,333	−0,486**	−2,956**	−0,307	−0,428*	−1,468	−0,012	−0,052	0,125	−0,051	−0,187	−0,954
N° of years qualification held																		
Less than 10 years																		
Between 10 and 15 years	−0,701**	−0,249	−3,468**	−0,336	−0,350	−2,683*	−0,544**	−0,223	−3,064**	−0,455	0,105	−1,117	−0,494**	−0,265	−2,247*	−0,300	−0,058	−1,118
More than 15 years	0,181	0,233	1,164	0,166	0,542**	2,300	0,242	0,181	1,634	−0,151	0,102	−0,044	0,075	0,126	0,847	0,025	0,229	0,527
Experience in health and safety coordination																		
Fewer than 10 works																		
Between 10 and 25 works	0,329*	−0,209	0,394	0,310	−0,297*	0,250	0,397*	−0,088	1,501	0,557**	−0,064	0,981	0,503**	0,042	1,330	0,438**	0,181	1,190
More than 25 works	0,364*	−0,219	0,477	0,492*	−0,125	1,414	0,502**	−0,038	2,060	0,594**	−0,071	1,147	0,302	0,028	0,638	0,353	0,021	0,924

* P less than 0.10
** P less than 0.05

observe this effect with more precision in Table 7.

The Andalusia Labor Authority codifies construction works into thirteen phases in its official accident investigation report. The six phases analyzed in this study, and shown in Table 8, have had the greatest number of accidents in the construction sector in recent years (Carrillo-Castrillo et al., 2017). The results confirm that gender is not significant in any of the phases, neither in the perception of likelihood, nor in the severity. This finding reinforces the existence of consensus between construction safety experts of both genders in the perceptions of risk.

We begin by observing that there is significance of the age variable in all phases of construction and in all categories. There is also an inverse linear type relationship in the perception of the probability of an accident that indicates that the older the subject, the less is his/her perception that certain construction activities give rise to accidents. This relationship is especially clear in the first three phases of the construction work, the ones with the highest level of risk.

Experts between 35 and 45 years of age usually perceive the highest level of risk, since they generally add to the effect described above, the greater perception of the severity of the consequences of the accident. Again, this effect is more evident in the early phases.

The installations phase deserves to be mentioned since, although it does not belong to the initial s of a construction work, due to its significance and effect on the perceptions and level of risk of the age variable, it is very similar. The perceptions of risk in the partition walls and finishes phases are the least affected by the age of the construction safety expert.

The results obtained for the engineer are significantly lower in four of the six phases, while the subjects belonging to the other three degree-disciplines perceive the levels of risk in a very similar way throughout the works, both in probability and severity. This finding is consistent with what has been indicated up to now in this study. We note that the significance for engineering studies is of a higher level in the facades and roofing phases. Similarly, the value of their perceptions and level of risk in these two phases is quite different from the rest of the university degrees. There is significance in the last phase of the construction work, finishes, for the perception of the severity of an accident's consequences and the level of risk of the activity in the Technical Generation category, while the other categories show very similar values to each other. Therefore, engineers stand out for their propensity to perceive less risk in the facades and roofing phases. The holders of a degree in ingeniero técnico are more likely to assess lower risk levels for the finishes phase.

In the case of the number of years a qualification has been held, its relevance is also greater in the early phases of the work, and in the installations phase. The professionals who obtained their accreditation to act as coordinators between 10 and 15 years ago experience risk levels of the activity and of the two parameters, likelihood and severity, well below the rest of the experts. Those more recently qualified and the oldest manifest a higher value of their perceptions.

The results with respect to the experience in health and safety coordination place it as the variable with the most widespread effect on the perception of the probability of an accident occurring in the construction activities of works. This variable is significant in the six construction phases analyzed. Its effect is observed in all phases of construction, with increases in risk perception in all significant cases over the reference category, experience in health coordination and safety of fewer than 10 works. We also observe that the probability perception values in all categories once the 10 jobs as a coordinator are exceeded are very similar. We can add that the estimates for likelihood show a clear linear pattern in structures, roofing and partition walls phases, so the greater the experience the higher the attributed likelihood.

7. Discussion

This study is novel when evaluating the effect of some socio-occupational variables on the risk perception of OHS experts in the construction industry in Andalusia. In addition, the document concludes by designing recommendations and future lines of research to reduce the variability detected and improve the acceptance of the evaluations. This work contributes to the set of construction health and safety knowledge by providing evidence regarding discrepancies in the perceptions of those responsible for approving the health and safety plan and its annexes and assessing the risk levels of construction processes during the execution of the work.

The results have indicated that the main causes of variability in the assessments of the level of accident risk, estimating the severity of the event that may occur and its probability of materializing, are significantly related to age and experience in health and safety coordination.

The results suggest that the coordinator for safety and health matters include the social attributes of the risks that they assess and that these assessments have an impact when they make decisions related to the OHS on preventive measures in the construction processes and, by extension, in the management of the risks.

On the other hand, the literature indicates that the effectiveness of their decisions can be seriously hampered when construction site stakeholders differ significantly in their understanding of the nature of an OHS hazard and / or opportunities for its control. Later we show the differences with greater specification according to the execution phase of the work.

In this case, the results coincide with (Cordellieri et al., 2016), which shows that both men and women have the same perception regarding risk situations. Although other authors state; that the perception and interpretation of occupational risks between the two genders do not always share a perspective (Cifre et al., 2011), or that there is an opinion that women have a greater sense of responsibility towards health issues, or that they are more alarmists, (Williams and Florez, 2002; Sjöberg, 2000), or that men reinforce their male identity by underestimating risk situations (Courtenay, 2000, Calvario Parra, 2007) or that apprehensions of women differ from men (Jerez Ramírez, 2015). These biases do not manifest themselves in the case of construction in Andalusia.

Age has also been frequently associated with risk perception, although the literature review does not provide a clear trend. Older people have expressed levels of concern higher or lower than their younger counterparts based on the exposures analyzed (Gallastegi et al., 2019; Subiza-Pérez et al., 2020). Subiza-Pérez (Subiza-Pérez, 2020), specifically states that gender and age are the most consistent demographic predictors of environmental health risk perceptions and Mohamed (Mohamed, 2003) discovered that introducing the age factor in recruitment improves the risk management of construction companies.

The results of the study are consistent with what several authors have said about the relationship between the age of the subject and the risk assessment in the construction industry (Petrakis 2005, Siu et al., 2003, Stoilkovska et al., 2015).

On the other hand, in other studies, reasonable evidence has been obtained to state that as age increases, so does the propensity to take lower risks and to adopt a more conservative behavior (Mitchell, 1995), which contradicts the decrease in the valuation of the perceived risk manifested by this study.

That said, the results are also compatible with the statements of other authors who state that the perception of risk changes over time (Hawkes et al., 2009) and that decision making is influenced by aging (Best and Charness, 2015) or that seems to show an increasing effect of age on risk ratings (older fishermen rated the risk as higher) (Davis, 2012) and contrary to those who have not identified differences in perceived risk according to age (Boix et al., 2001, Basha and Maiti, 2013).

The reasons for these changes, although there is evidence that cognitive changes have a basis in the change in the perception of the

environment, secondary to the decrease in visual and auditory capacity that accompanies age, the causal relationship between these domains it is still a matter of study and discussion (Salech et al., 2012).

The hypothesis of considering age as a factor, which has a direct relationship with the perception of the level of risk by those whose functions include evaluating that level in the field of OHS in construction, hypothesis (1), must be rejected, since although it has significance, it is in the opposite direction, i.e. reversed.

There is a specific framework applicable to the study plans of each university degree that puts a set of rules before it, although they are flexible, but binding. The title of arquitecto técnico is the university study with more dedication in its configuration and greater specialization in health and safety. Their study plans enhance the skills and roles of the coordinator for safety and health matters among students.

However, in this study only one category of this factor emerges significant, which corresponds to the university engineering study of 4 or 5 years in duration and on the perception of the severity of the consequences of the accident and its level of risk. Gravity is quite difficult to estimate previously due to the existing multiplicity of possible consequences for a given accident. (Törner and Pousette, 2009). Zhao, McCoy, Kleiner, Mills, and Lingard (Zhao et al., 2016) attributes the comparatively high-risk assessment of engineers to their obligation to ensure satisfactory construction performance in their design and calculation and the low degree of intragroup agreement attributed to individual factors.

Other researchers have shown that while there is a high degree of consistency between managers' perception of risk decision making, there is a particularly large gap among the workforce (Chen et al., 2012). Obtaining accurate results, in particular, about the effect that the degree of an engineer has on the perception of the consequences of an activity on construction sites is very difficult to achieve. This would require a thorough analysis of the contents of the university curricula, but it seems to show some small divergence in an engineer's university education that has not been corrected by the subsequent training in occupational risk prevention in construction works to acquire the competence and specialization.

Although university degrees, both undergraduate and master's degrees, qualify someone to carry out regulated professional activities in Spain, the government must establish conditions for their study plans, and these plans must be designed to obtain the necessary competencies to practice that profession. The autonomy of each university introduces differences between them; the subjects leading to completion of the aforementioned competencies are usually not defined in the same way (Muñoz and Alonso, 2015).

The long judicial battle, from the creation of the professional career, on the competencies of the coordinators, depending on their professional competencies and specialization, that is, that only those who are authorized to carry out projects and / or direct certain activities, should be the ones who can carry out the coordination for safety and health matters of the same, it seems to be a hypothesis that should be rejected, in the same way that hypothesis (2) of our study should be rejected, when the results are taken into account.

The time elapsed since the participants obtained the job qualification as coordinator of health and safety in construction work is a variable that represents the progress of the economic cycles and the evolution of the technique.

The early phases of the working life of any professional, especially in the field of prevention of occupational risks in construction, an area with a strong production-prevention dichotomy, contains numerous obstacles (McLain and Jarrell, 2007). The results observed lead us to propose that the suggested changes in regulatory innovations, new laws and requirements to be complied with and new techniques and procedures to be implemented, seeking to adapt to emerging risks, technological changes and a high and persistent occupational accident rate, produce an extended effect over time (Abdullah and Wern, 2012; Dulaimi and Chin, 2009). The different stakeholders in the sector (legislators, employers, trade unions, professional associations, etc.) also contribute to the lack of consistency, pressuring and intervening according to their interests, trying to influence the emerging professional profiles (Boix, 1999).

The passage of the construction sector through growth cycles and economic crisis have surely left lasting effects on a large part of society and on the population linked to the construction industry in particular. It is enough to check how the economic cycle in Spain has an impact on workplace accidents (Fernández-Muñiz et al., 2018) and the existence of associations between business cycles and the incidence of injuries in the construction sector, although not in other sectors (Asfaw et al., 2011).

The effect of variable work experience is one of the most studied in risk perception. The perception of risk is modified by experience and does not remain unchanged over time (Tierney, 1999, Mohamed et al., 2006, Starren et al., 2013). Effective OHS risk management relies on the ability of decision-makers to recognize hazards, assess the implication of these hazards, and determine appropriate interventions (Aires et al., 2010).

There are studies where the authors have not identified differences in perceived risk according to experience (Basha and Maiti, 2013). Mohammad (Mohammad, 2006) found that homeowners and consultants rated inexperienced engineers among the top three causes of construction delay in Hong Kong. Another study shows that the effect of the years of experience of construction personnel on their perception of danger reveals, for the most part, a significant difference, however inconsistent, due to a lack of adequate and continuous safety training (Abbas et al., 2018). Other studies show that as experience increases, the risk of the activities is overestimated, viewing a large number of work situations as dangerous, formulating unrealistic situations and altering the normal development of the processes (Mohamed et al., 2009 Starren et al., 2013).

This study also shows a significant difference in the effect of years of experience in OHS experts in construction and with a positive relationship. The increase in the score of the estimate of the probability that the risk of an accident occurring, once the experience exceeds 10 works materializes and will then remain almost unchanged with the increase in experience. It appears that the increase in actual practice of risk assessment and health and safety communication on the construction site is very significant. As occurred with hypothesis (1), hypothesis (3) must also be rejected, not for lack of significance, but rather for moving in the opposite direction, i.e. positive.

The uncertainties present in construction works are usually exacerbated in the initial phases, to which is added that each construction project is unique and each construction site becomes a “factory” where the construction project is produced (ILO, 1997). As a result, although many aspects have been planned (locations, accesses, storage, order and sequence of tasks, etc.) the initial and first phases of the work have greater imbalances and changes in planning (Gangolells et al., 2010). In the work presented here, the first three phases investigated concentrate most of the significant results and the greatest discrepancies among construction safety experts.

8. Conclusion

The present paper has described an experimental study that has investigated the perceptions of the experts on the risk in construction. The study has analyzed and compiled data from 2460 accident risk-level perception evaluations, obtained from joint perceptions of frequency and severity of the consequences of the production of an occupational accident in 30 work activities around the construction site.

The results reveal that coordinators for safety and health matters, critical safety roles in construction projects, have demonstrated a certain degree of consensus on all the factors analyzed. This resulting consensus is consistent with the theory of social construction of risk, manifesting the intervention of various factors in the process of

individual perception and pointing out that no subject, no matter how experienced he/she is, is free from this effect.

The results have also revealed that the experts when scoring the levels of probability and consequences of an accident materializing, do so reflecting a certain individual bias due to his/her culture's sense of risk. All experts have different estimates of the probability of risk. Specifically, they have been significant factors, after statistical analysis to determine the factors that affect the experts' perception of risk and the scope and magnitude of those effects; the increase in age reduces the score of the levels of perceived risk, only the university engineering studies of 4 or 5 years duration and with a reduction effect on the perception of the severity of the consequences of the accident and its level of risk, the qualifications obtained in the midst of the economic crisis and with a reduction effect on the perception of the frequency of the accident and its level of risk, and lastly, once they have been working as a coordinator for a time, and have gained experience, the tendency to evaluate a higher risk appears and from then on remains, regardless of continuing professional experience. This effect is an increase in the perception of the frequency of the accident.

This work has revealed some variability in risk perceptions, and has contributed to some extent to answering the why question. Future research should increase the answers to those factors that explain the discrepancies in the perceptions of the level of risk and its components of probability and consequences, as this study has not been able to explain much beyond between 20.9% and 37.5% of the different models (Snijders / Bosker R-squared level 1 and level 2)

The results also have practical implications for improving risk management in the construction industry. The risks of OHS in the construction phase can often be traced back to the decisions made by people who are not in that phase and who in previous phases decided on construction processes and their specifications. These decisions are often made before construction work begins. The improvement in the evaluations of the risk levels, by controlling the variabilities revealed, in the project phase, would allow an exhaustive verification to be carried out between the health and safety study of the works object of the project for the approval of the safety plan, the health and safety coordinator during the project execution stage would be easier, it would also help to harmonize the assessments of the risk levels among all the participants in a construction project, helping to make decisions regarding OHS are more easily accepted by the workers who will be affected by them and, consequently, would contribute to improve risk management in the construction industry.

The present study has provided useful and interesting information on the relationship between various socio-occupational factors and the perception of the risk of accidents in the common activities of construction works and on that basis we will recommend to increase the coherence of risk assessments, contributing to improving the basis of decision-making that follows risk assessment.

Although our target population for this study is focused on a territory such as Andalusia, the fact that there is significant variability in various socio-occupational factors suggests that a larger study among experts from another country or where more diverse social and cultural factors are included will produce in the results an even greater variability, probably significant. Extending this work could take the form of an investigation into the reasons why experts from different cultures and with different degrees of development in the construction industry perceive risk levels differently.

Regarding the contributions of measures to increase the coherence of the risk level assessments, the following results emerge from the study:

• Provide training on occupational risk prevention in all university studies whose degrees appear as an enabler for the professional career of coordinator for safety and health matters.

• Establish the complementary training requirements to those taught at the university in a definitive and compulsory way.

• Establish a permanent training system for coordinators for safety and health matters that keeps the knowledge and skills of these professionals up to date on methods of risk management, evolution of construction processes and construction materials, evolution of preventive measures and communication on health and safety.

• Promote events and forums that allow the exchange of experience between health and safety experts in construction works, especially on risk assessment in construction processes and circumstances in the execution phase of work that frequently substantiate their dangers in accidents.

• Improve risk assessment methods incorporating measures that control the variability of the assessors due to individual factors.

The perceptions of the construction safety experts on the risks of the usual activities in the initial phases of construction are those that match least. This is one of the most relevant findings of this study. It is essential that the coordinators reinforce their knowledge of construction techniques and the results and advances generated in risk management in these phases. In addition, it seems reasonable to conclude that the approach to risk assessment of a construction site should pay special attention to the initial phases of construction work, considering and evaluating various alternatives / strategies, in collaboration with workers, which improves the valuations based on the subjective judgments of the experts.

There are limitations to this study due to the fact that a neutral and purely technical situation has been established by means of a fixed image against the perception of risks in real conditions. Another limitation is implicit in the use of online surveys meaning the sample may not be sufficiently representative. In addition, although the photographs used in this study belong to existing building construction projects, they may not adequately represent construction techniques and, of course, are not representative of all construction works.

The findings of this study can provide baseline information so that those responsible for managing occupational risks adjust their assessments and improve the quality of decision-making based on these influences to reduce and control construction risks, encouraging experts to be constantly up to date and sharing experience with other professionals. These findings can be used as preliminary results to develop studies with an improved focus on other factors that affect the perception of risk in the sector. In addition, they suggest other lines of future research, with respect to the role of the health and safety coordinator and the influence that other variables may have on perception of risk, i.e. inexperience.

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