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AN ANALYSIS OF WORK ACCIDENTS STATISTICS IN THE ROMANIAN CONSTRUCTION INDUSTRY AND APPLICABLE STRATEGIES TO MINIMIZE RISKS

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Abstract: *The purpose of this article is to make an analysis of the undesirable events that took place in the construction industry in Romania in relation to the last 10 years from a multi-criteria perspective, with an emphasis on the legislative and statistical components. The research approach aimed at identifying and establishing the most appropriate strategies available to minimize the risks specific to this sector of activity. Three specific approaches to risk management applicable in the construction industry were investigated, namely: occupational health and safety management systems, behavior-based safety and security culture change programs, concluding that just by simply complying with legal requirements in the construction field, the needs for organizing activities specific to worker safety and health are not fully covered. At the same time, resorting to the pragmatic, realistic and feasible method of gradually improving the level of safety culture (through either top-down or bottom-up approaches) represents a basis and - at the same time - a guarantee, of the positive evolution of pro-safety behaviors and - implicitly - of reducing the probability of occurrence and/or the consequences and severity of occupational diseases.*
Keywords: *occupational health and safety (OHS), accident statistics, construction industry, risk management strategies*

1. Introduction

The construction sector represents a field whose activity has a particularly important economic weight, an aspect highlighted by the value of investments in the field, both at the European level and at the level of each country [1, 2]. The typology of construction works that are the subject of investments in the field is a vast one, from civil construction works (blocks, residential houses, etc.), to the construction of highways and roads, which include different and complex types of specific works, which makes this field universally recognized as having a high level of risk. In the construction sector, in the member states of the European Union, approximately 13 million employees work, after approximately 11.8 million employees worked in this sector in 2011. The construction sector consists mainly of small and medium-sized enterprises (SMEs). According to the estimates of the Federation of the European Construction Industry, 95% of these SMEs have less than 20 employees [3].

Due to its specificity, construction activity exposes workers to a wide range of occupational injury and/or disease risks, to which other aspects are added, such as: the mostly low level of staff training, the seasonal nature of the work, the variable work environment, the frequent change of location, the high percentage of workers without legal forms [4].

For ***Romania***, the construction industry makes an important contribution to the economy, contributing approximately ***7% of GDP***. The role of the construction industry can be seen through the lens of the potential to increase the number of jobs created considering in particular the infrastructure development projects announced at the national level. At this moment, according to the data of the Ministry of Labor and Social Protection, approximately 440,000 workers in Romania work in the construction sector, covering

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approximately ***8% of the workforce*** in all sectors. This dynamic is closely related to the value of the investments in the field of construction in Romania, investments that reached the level of approximately 28 billion euros after in 2016 they were at the level of approximately 16.8 billion euros [5]. The development of the construction service industry becomes an important part of the government's agenda in the coming period, which directly involves internal problems in the form of the ***dynamics of construction safety culture***, which is still an issue in every construction project [6]. These ***challenges*** require legislative efforts and strengthening the security and institutional regulation of the construction services sector to ensure that this sector can grow and develop, has a continuous increase in added value, professionalism and competitiveness. Health and safety at work is a field of research, presenting multiple areas of interest: at an economic, legislative, ethical and moral level [7, 8].

Poor planning and low levels of foresight result in a considerable number of accidents occurring within the construction sector. Choudry [9, 10] states that 46.8% of accidents are closely related to issues related to the design for safety concept, which highlights the fact that poor project planning in the "Preparation" stage has resulted in the production of more than half of the work accidents that occur on construction sites in the European Union [11]. Most of the occupational health and safety problems that arise during the construction phase can be avoided by increasing the effort made in the initial phase of the project. Thus the risks can be reduced already from this phase, the OSH requirements in the pre-construction phase being identified as an effective and successful technique in the management of safety and health at work on the construction site. This indicates that the OSH Plan is not only identified as a bureaucratic requirement, but is of defining importance for the continuous improvement of working conditions when the plan is continuously adapted in line with changes in the workplace situation [12].

In the planning phase of each project, decisions are analyzed and taken regarding the management of the necessary resources, these activities having a much higher level of effectiveness at this stage than later. In this regard, based on the forecast and planning, to ensure the safety and health of workers, the OSH Plan is drawn up, thus becoming the basic managerial tool that establishes concrete prevention measures on construction sites. The fulfillment of each measure ordered in this regard is essential, taking into account the fact that dangerous situations can occur, in different forms and at variable levels of severity that may even have irreparable consequences, throughout the duration of the project. [13].

Health and safety should be seen from a broader perspective, recognizing the essential characteristics of work and the work environment that exert a direct or indirect impact on health. In this field should be included *leadership and management, work organization, communication and information, work methods, continuous professional training, the social work environment* that allows achieving the balance between work and family [14].

The purpose of this article is *to analyze the evolution of unwanted events from the point of view of their statistical evolution and to investigate the strategies available to minimize specific risks in the construction industry in Romania*.

2. Legislative and organizational policy responses to unwanted events in the construction industry

The general principles of prevention represent one of the central elements of the legislation of the European Union (EU) regarding the safety and health of workers. ***Directive 89/391/EEC of the Council of the European Community of June 12th, 1989, on the implementation of measures to promote the improvement of the safety and health of workers at work*** (known as the "framework directive"), transposed into national legislation by the Safety and Occupational Health Law no. 319/2006, introduced measures to encourage the improvement of safety and health conditions for all workers and established a comprehensive risk control strategy at all workplaces. Thanks to this, the general principles of risk prevention, assessment and management have become fundamental elements for ensuring safety and health at work. The same strategy was also adopted in ***Directive 92/57/EEC of the Council of the European Community of June 24, 1992*** regarding the minimum safety and health requirements that apply to temporary or mobile construction sites [the eighth specific directive in the sense of art. 16 para. (1) from Directive 89/391/EEC, transposed into national legislation by ***H.G. no. 300/2006***[†] ***regarding the minimum health and safety requirements for temporary or mobile construction sites,*** which must be taken into account by the various stakeholders mentioned in the text of the directive [6].

[†] *amended and supplemented by: H.G. no. 601/2007* for the amendment and completion of some normative acts in the field of occupational health and safety

Directive 92/57/CEE of the Council of the European Community of June 24, 1992 regarding the minimum safety and health requirements that apply to temporary or mobile construction sites, transposed into national legislation by H.G. no. 300/2006 regarding the minimum safety and health requirements for temporary or mobile construction sites, details the provisions for the construction sector and specifies the responsibilities of the interested parties involved in the prevention of OSH risks, emphasizing the need for their assessment and the integration of their prevention from the moment of conception/design the construction site and up to the phase of existence of the construction. H. G. no. 300/2006 introduced major changes regarding the prevention of occupational risks in the construction sector by:

- the introduction of the obligation regarding coordination in matters of health and safety, both during the elaboration of the work project and during its realization; the health and safety coordinators prepare the intervention of the various interested parties (beneficiary, project manager, contractors, as the case may be, subcontractors, independent workers, etc.) on the construction site and consider the subsequent operations of modernization, modification, transformation, consolidation and maintenance of construction;
- clarifying the roles and responsibilities of the various interested parties;
- the introduction of the obligation to draw up some documents (coordination tools: the safety and health plan, the own safety and health plan, the coordination register, the file of subsequent interventions) that contribute to ensuring good working conditions and an appropriate level of security and workers' health;
- the extension to all interested parties who carry out their activity on the same construction site of the obligation regarding compliance with the principles set forth in Directive 89/391/EEC of the Council of the European Community of June 12th, 1989 on the implementation of measures to promote the improvement of the safety and health of workers at the site of work ("framework directive"), in order to cooperate and coordinate them in the field of occupational risk prevention.

This directive promotes better working conditions on construction sites, taking into account the fact that workers can be exposed to particularly high risks. It also highlights the need for the responsibilities of each person involved regarding OSH and the procedures for their implementation to be established in the initial stages in order to avoid any risks. For this, the decision on the use of specific management tools for prevention in construction is generally configured through the following types of documents: Prior Notification, Adapted File and OSH Plan, the latter being the main management tool used at European level. In addition, the implementation of a well-planned/drafted specific OSH plan at the workplace results in a low level of accidents. Therefore, the reality can be considered alarming, indicating in many situations a lack of effectiveness of the OSH Plan, which is materialized by exposure to risks resulting in damage to the health and physical integrity of workers.

This diversity appears predominantly in the preparation of the plan, highlighting two approaches materialized by using a single document that is updated during the course of the works and by developing a system centered on two documents specific to each phase of the project, an example in this regard being the following national cases [15]:

- ***Italy*****:** Safety and Coordination Plan / Operational Safety Plans or Substitute Security Plans;
- ***Portugal***: OSH Plan in the project phase / OSH Plan in the work execution phase;
- ***France:*** General Coordination Plan / Particular OSH Plan (drawn up by each contractor or subcontractor company);
- ***Luxembourg***: OSH Plan / Specific Safety Plan;
- ***Spain:*** OSH Study (hereinafter referred to as OSH Study) or Basic OSH Study incorporated in the project / OSH Plan drawn up by each contractor.

Each member state has a different approach for the implementation of the Directive 92, related to the relationship with the agencies obliged to draft the text of national transposition (Table 1).

In the case of some construction projects, the decision-makers may consider that it is more appropriate for such cooperation to be formalized and made concrete by drawing up an ***integrated register regarding the risks of the project***, even if H.G. no. 300/2006 - regarding the minimum safety and health requirements for temporary or mobile construction sites does not provide for any legal obligation in this regard. The use of integrated risk registers, when some interested parties cooperate to manage OSH risks within a project, is a particularity of risk management in construction. In such situations, for each stakeholder, beneficiaries, designers, health and safety coordinators, workers, etc., it is necessary to carry out a common risk assessment and create a single integrative document to be used in the project. The advantage lies in the fact that all stakeholders are involved in identifying hazards and, most importantly, can cooperate to eliminate them or

reduce risks throughout the life of the project with those in a favorable position after accepting the tasks that were assigned to them.

Table 1. Implementation of Directive 92 in 22 EU member states

	IMPLEMENTATION OF THE OSH PLAN
92/57/EEC Directive	Before starting construction, the beneficiary or the manager of the work will ensure that an OSH Plan is established. The OSH coordinator or coordinators during the development of the work project will establish or draw up an OSH Plan in which the applicable rules are specific to the respective works.
PORTUGAL	The designer must develop the OSH Plan for the work during the project phase. It is the responsibility of the safety coordinator to prepare the project's OH&S Plan from the design phase, but if it has been carried out by another person at the request of the designer, it must be validated, subsequently developed and finalized by the main contractor. The security coordinator during the execution phase of the work must evaluate the progress and changes of the OSH Plan for the execution of the work and propose to the executor appropriate changes for technical validation.
ROMANIA	***The law expressly states that the designer/general contractor or project manager will be responsible for the development of a general OH&S Plan of the work through a Coordinator. The OSH plan will be carried out for works involving several companies (contractors, subcontractors or independent workers) on the work site. The law states that each contractor and subcontractor has a period of 30 days. to make available to the main contractor or the occupational health and safety coordinator an own OHS Plan that is harmonized with the general OHS Plan.***
BULGARIA	The Project Phase OSH Coordinator, appointed by the Designer/General Contractor, will be responsible for establishing the Site OSH Plan. The contractor must make the OSH Plan available to subcontractors and other persons with access to the work.
SPAIN	During the project phase, the designer/general contractor is required to prepare the OSH Study or OSH Baseline Study, in accordance with the requirements related to the budget and execution period, as well as the presence of workers on site. The main contractor will prepare an OSH Plan in which the provisions contained in the study or the basic study are analyzed, studied, developed and completed, depending on the own system of execution of the works. The OSH plan must be approved before the start of the work by the coordinator or expert, as the case may be, always be available during the work and updated.
FRANCE	The designer/general contractor will prepare the General Coordination Plan, review the OH&S Plan prepared by the contractors and conduct the joint inspection visit during the design phase of the project, as well as the joint pre-inspection with each of the contracting firms before the work starts. They will draw up an Intervention File during the work until its end.
ITALY	The security and coordination plan must be developed by the developer through the security coordinator when there are several companies executing the work, even if not at the same time. Each contractor must appropriate it in order to execute the work. It is advisable to communicate to the coordinator any changes considered appropriate as the activity develops.
UNITED KINGDOM	The designer/general contractor is required to prepare and distribute the information prior to the execution of the work, which is done for all projects where there is more than one contractor involved. It is prepared by the PP Principal Designer, subject to modifications executed whenever the project requires it. It is necessary to be physically on site. The OSH plan is only required in projects where the appointment of the Principal Designer and the Principal Contractor is mandatory. During the work and until its end, the SSM File must be prepared containing all the indications regarding the prevention of risks transmitted during the execution.
NETHERLANDS	The designer/general contractor/beneficiary must guarantee the preparation of the OSH Plan when the work is included in Annex II of Directive 92/57/EEC or is a work that must be notified.
SWEDEN	The document will be available to interested parties and will be delivered to all companies involved in the work. The OH&S Coordinator in the planning and design stages will prepare the OH&S Plan with relevant information about the construction works and for the subsequent repair, maintenance activities, including the demolition activity where applicable. He is also responsible for ensuring that the Plan is constantly in place, making any necessary adjustments as the work progresses.
DENMARK	The designer/general contractor must ensure that the OSH Plan is prepared through the OSH coordinator, as well as that he makes adjustments in the log and keeps the plan available throughout the execution period of the work to all parties involved in the work.
POLAND	The OSH plan is the obligation of the designer/general contractor/beneficiary or main contractor upon acceptance by the designer/general contractor.
FINLAND	The designer/general contractor/beneficiary reviews the OH&S Plan of the contracting firms, and also develops the prevention rules that it transmits to the subcontractors.
IRELAND	The Beneficiary appoints the safety coordinator who is responsible for the preparation of the preliminary OSH Plan. During the execution of the work and until its end, a Safety File must be drawn up that must include all the guidelines regarding the prevention of existing risks and identified during the work as well as the preventive measures that must be taken into account for the subsequent phases of maintenance.
LUXEMBOURG	The Beneficiary draws up the General Coordination Plan and revises the Safety Plan of the contracting companies, subsequently creating the Intervention File during the work and until its end.
NORWAY	The Beneficiary will ensure that an OSH Plan is made, prepared by the Coordinator before the start of construction work. The plan will be accessible to workers and companies and will be promoted in the relationship between contractors and subcontractors.
SWITZERLAND	Each company must have its own regulations, which establish the necessary provisions regarding OSH and the prevention of occupational risks. The regulations are submitted to the cantonal authority and must be approved by them. Once approved, subcontractors and their workers must comply with these provisions.
CROATIA	The OSH plan is the responsibility of the beneficiary, being drawn up before the start of the works by the OSH Coordinator. That plan will be part of the documentation related to the design stage. The beneficiary must deliver it at the time of notification of the start of the works.
BELGIA	The site manager or site design manager will appoint a project coordinator responsible for the preparation of an OSH Plan prior to the opening of the site. The project coordinator or the project implementation coordinator will establish in the OSH Plan whether workers are exposed to specific risks. A simplified OSH Plan will be carried out when there are no specific risks.
GERMANY	The Beneficiary must ensure that an OSH Plan is established for each individual work.
AUSTRIA	The Beneficiary must ensure that there is an OSH Plan before starting any work. The beneficiary will inform the contractor about the existence of significant risks. The OSH plan must be adapted to the evolution of the works to ensure the safety of the workers. The safety managers of the contractors are consulted for the realization of this plan. The beneficiary must guarantee that the employers involved are informed about the OSH Plan.
GREECE	Before work starts, the developer or main contractor will ensure that an OSH Plan is drawn up. Each contractor who joins the site with jobs for a period of more than 5 days must prepare his own OSH Plan or adhere to the General Plan if it covers the necessary risk aspects.

The safety and health coordinator during the development of the work project is the most competent to develop an integrated register of risks for the interested parties within the project team. When there is no such a person, it is recommended that beneficiaries, designers and contractors prepare simple integrated risk registers that take into account the type and magnitude of hazards.

3. The relevance of work accident statistics

According to ILO statistics, it is estimated that approximately 22,000 deaths occur annually because of work accidents and approximately 6,400,000 workers are injured at work [8].

In 2023‡, there were 2,886,507 non-fatal occupational accidents and approximately 3,347 fatal accidents at EU level during working hours. From the point of view of non-fatal work accidents, we can observe a rather large difference in the values of the frequency index at the level of our country compared to the other European states, in the entire evolution presented in the interval 2013-2023, even if its value is on a downward trend.

This may be due to insufficient reporting of work events at the level of employers, this aspect being a subject of analysis in itself. In the same year, the data places Romania in 5th place, with no less than 3 fatal accidents per 100,000 employees, but a positive evolution can be observed compared to the index from 2020. The most fatal work accidents per 100,000 employed persons are recorded in Latvia with an index of 4.29, Lithuania with an index of 3.75, Malta with an index of 3.34 and France with an index of 3.32.

In Romania ***(****https://www.inspectiamuncii.ro/statistici-accidente-de-munca****)***, the situation of fatal accidents at work, registers a downward trend, from 318 in 2014 to 90 in 2023 with small fluctuations between 2014-2018, contrary to the trend of increasing the total number of accidents, and with steeper decreases in 2020 and 2021 amid the drastic measures taken during the COVID-19 pandemic, when in some periods of time it was even ordered to stop the activities or resume them with restrictions in accordance with the evolution of the total number of accidents (see table 2, figures 1 and 2).

Table 2. Evolution of the situation of work accidents in the period 2014 - 2023

Work accidents	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Total number of persons victims of	318	321	278	321	281	278	204	201	155	90
fatal accidents/ Frequency index	*0.06*	*0.06*	*0.05*	*0.06*	*0.05*	*0.05*	*0.04*	*0.04*	*0.03*	*0.02*
Temporary incapacity for work (LTI-Lost Time Injuries)	3958	4582	4917	5372	5526	5591	4539	4791	4819	4772
Total number of victims of work	4276	4903	5195	5693	5807	5869	4743	4992	4974	4862
accidents/ Frequency index	*0.87*	*0.97*	*0.99*	*1.06*	*1.07*	*1.07*	*0.88*	*0.90*	*0.89*	*0.86*

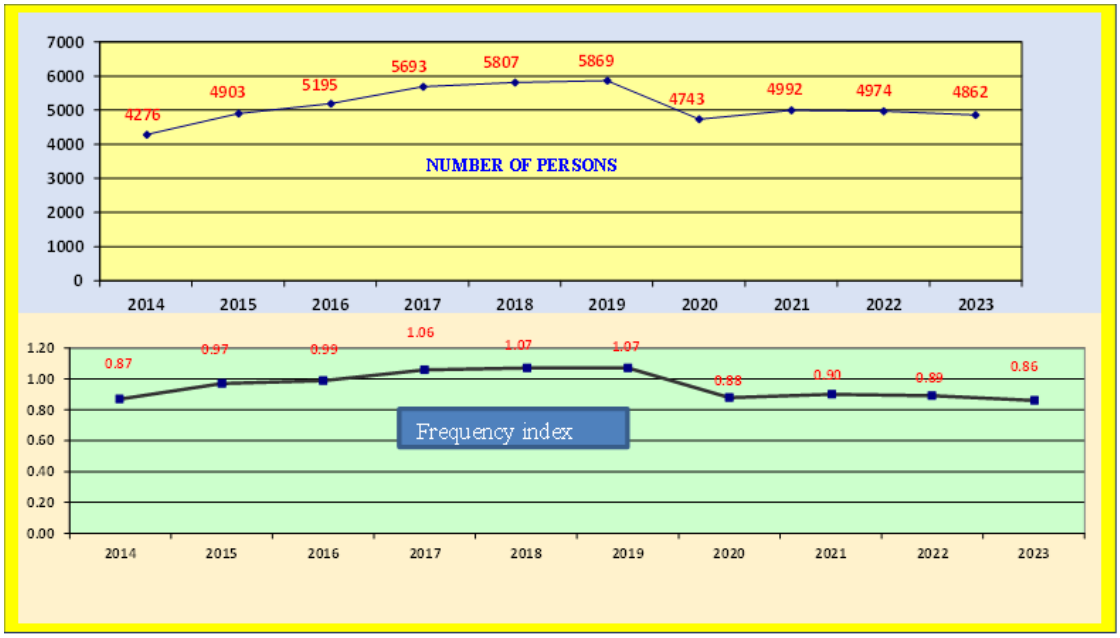


Fig. 1. Evolution of the number of victims of work accidents in the period 2014-2023

‡*Full data at EU level until 2023 according:*
https://ec.europa.eu/eurostat/databrowser/explore/all/popul?lang=en&subtheme=hlth.hsw.hsw_acc_work.hsw_n2&display=list&sort=category&extractionId=hsw_n2_02

Compared to the year 2022 when a number of 4,974 injured people were registered, in the year 2023 there was a decrease of only 0.02% to 4,862 injured people, the frequency index (the number of injured people returning to 1000 employees) being 0.86 ‰. in 2023 compared to 0.89 ‰ in 2022.

For people who ended their incapacity for work in 2023, the average duration index (the number of days lost, on average, by an injured person) was 50.7 days, 7.65% lower than in 2022, when it was 54.9 days. The severity index (the total number of days of work incapacity, relative to 1000 employees) was 32.6‰, 8.93% lower than in 2022, when it was 35.8‰.

In 2023, there were 90 fatally injured people, 41.93% less than in 2022, when there were 155 fatally injured people.

The frequency index (the number of fatally injured persons per 1000 workers) was 0.02‰ for all fatally injured persons, down 33.33% compared to 2022, when it was 0.03‰.

The sectors of the national economy in which the most work accidents were registered in 2023 are presented in table 3.

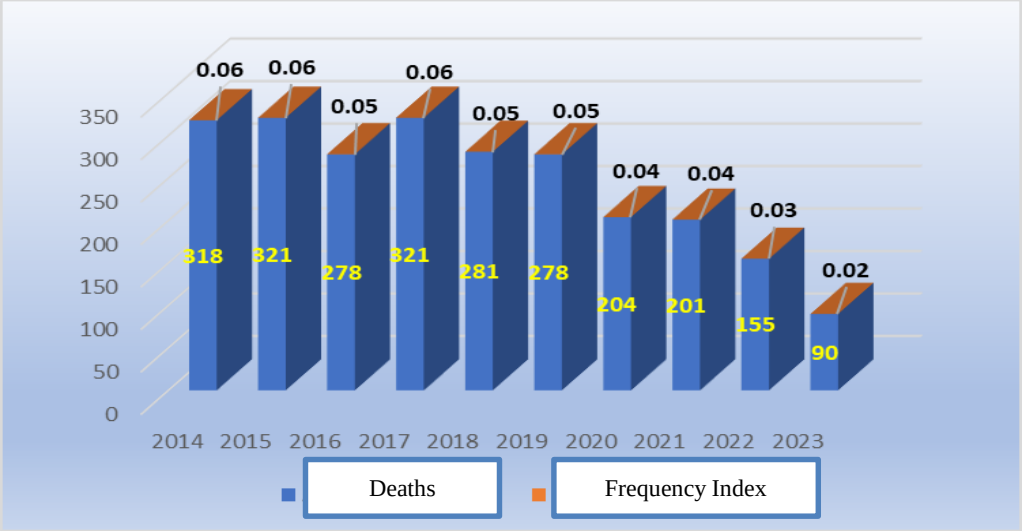


Fig. 2. Evolution of the number of victims of fatal work accidents, including the frequency index during 2014-2023

Table 3. Sectors of the national economy in which there were the most work accidents in 2023

Activity sector	**2022**	**2023**		
	Number of injured workers	Number of injured workers	Percentage of total casualties from the national economy	The difference from the year 2022
Retail trade, except motor vehicles and motorcycles	489	449	9.2%	-8.17%
Unreported activity	367	442	9.1%	+20.43%
Construction of buildings	**339**	**253**	**5.2%**	**-25.36%**
Land transport and pipeline transport	275	250	5.1%	-9.09%
Activities related to human health	202	208	4.3%	+2.97%
Food industry	160	194	4.0%	+21.25%

From the centralized data related to the year 2023, we note that in the field of construction there was the most consistent positive evolution of work accidents compared to the previous year with a decrease of over 25%, being thus overtaken by two economic fields in terms of number and percentage of the total reported to the national economy. The sectors of the national economy in which there were the most fatal accidents at work in 2023 are presented in table 4. Although the fields of building construction and civil engineering work remain leaders in the number of fatal accidents, we observe a strong downward trend in these types of events compared to the previous year, by approximately 59% and 61%, respectively, in line with the trend of the total number of fatal accidents in the year 2023.

Table 4. Sectors of the national economy in which there were the most fatal accidents in 2023

Activity sector	2022	2023		
	Number of injured workers	Number of injured workers	Percentage of total casualties from the national economy	The difference from the year 2022
Construction of buildings	**27**	**11**	**12.2%**	**-59.25%**
Land transport and pipeline transport	12	9	10.0%	-25%
Forestry and logging	14	8	8.9%	-42.85
Works of civil engineering	**18**	**7**	**7.8%**	**-61.11%**
Agriculture, hunting and related services	10	5	5.6%	-50.0%
Wood processing, manufacture of wood and cork products, except for furniture	6	3	3.3%	-50.0%

Having an important concentration of economic activities, Bucharest remains in first place in relation to the number of accidents with a weight of 22.04% of the total in 2023, the difference compared to the county with the second weight at national level being very large, the county Brașov having a share of work accidents of 5.92%. The highest number of fatal accidents at the national level were in Alba counties - 7 accidents with a weight of 7.77%, Galati and Gorj with 6 accidents each with a weight of 6.67%. From the point of view of the age of injured persons, the analysis of work accidents highlighted the fact that persons aged between 50-60 years have the highest share, of 30.5%, followed, with a close value, by persons aged between 40-50 years old, who account for 24.9% of all injured people in 2023. Also, people in the 30-40 age groups years old and under 17 years old and over 60 years old have quite high percentages, of 14.5% and 13.3% respectively, of the total number of fatal accidents in 2023. Regarding fatal work accidents, it can be observed that the 50-60 and 40-50 age groups have the highest share with values of 42.2% and 23.3% respectively.

The analysis of work accidents from the point of view of seniority at the workplace of the injured shows that 42.1%, i.e. 2047 workers out of the total number of injured, are people with up to 5 years of seniority (of which 25.1%, i.e. 1220 injured workers have up to 1 year of seniority at the workplace), and those in the 5 to 10 years seniority group represent 7.7% from the total number of injured.

4. Analysis of the work accidents statistics in the field of construction

The most recent data on fatal construction accidents worldwide suggest that quite a large number, in the thousands, of fatal accidents occur each year on construction sites around the world, the equivalent of one death every few tens of minutes [8]. Furthermore, one in six fatal workplace accidents occur on a construction site, and this rate is higher in industrialized countries, where 25-40% of all workplace deaths are on construction sites.

At the level of the European Union, according to the statistical data presented in the databases of the European Commission on the Eurostat website, contained in Table 5, in the period 2013-2021 in the construction sector the number of fatal accidents, respectively injuries and occupational diseases is higher than in any other activity sector, with an evolution of values between 11% and 13% % of the total work accidents and with values between 20% and 23% of the total fatal work accidents in the industrial sector, and the probability that employees in this sector suffer a work accident with temporary incapacity for work is twice as high as the average in the other sectors of activity. Slipping, tripping and falling from the same level, as well as loss of control over tools and manually operated objects are the most common causes leading to accidents resulting in temporary incapacity for work, while accidents resulting in death are mainly caused by falling of persons or objects from a height and loss of control over means of transport or machinery used in construction works.

It can thus be observed an evolution of deaths in the field of construction in the period 2013-2021, with oscillating values between 733 (2013) and 741 (2021). To these values are added seriously injured people, on average 360-370 thousand annually, as well as people exposed to asbestos fibers approximately 250-260 thousand annually, compared to the same period. Over 50% of the number of construction workers are prone to osteo-musculo-articular and auditory ailments due to the specific working conditions. Thus, annually, several million working days are lost worldwide due to work accidents and occupational diseases. Despite all the efforts to improve safety and health at work in this sector, the number of work accidents and occupational diseases remains unacceptable and involves an extremely high cost (more than 3% of the turnover of the sector).

Table 5. Evolution of the main indicators of work accidents occurring in the period 2013-2021 in the field of construction, in the European Union

European Union	2013	2014	2015	2016	2017	2018	2019	2020	2021
All fields of activity									
Total number of accidents	**2,936,708**	**3,031,648**	**3,030,077**	**3,112,736**	**3,116,691**	**3,124,828**	**3,140,950**	**2,735,566**	**2,886,507**
Fatal accidents	**3,408**	**3,562**	**3,643**	**3,336**	**3,272**	**3,332**	**3,408**	**3,358**	**3,347**
Construction field									
Total number of accidents/ Weight	353,950	351,663	347,293	347,467	352,575	362,630	371,800	339,907	369,145
	12.05%	11.59%	11.46%	11.16%	11.31%	11.60%	11.83%	12.42%	12.78%
Fatal accidents/ Weight	**733**	**740**	**767**	**672**	**679**	**682**	**755**	**691**	**741**
	21.50%	**20.77%**	**21.05%**	**20.14%**	**20.75%**	**20.46%**	**22.15%**	**20.57%**	**22.13%**

This situation can also be found in Romania, in recent years the number of fatal work accidents in construction has reached the level of European statistics, with not very big differences, however, from the fields of activity placed in the following places, land transport and pipeline transport, respectively forestry and processing the wood. Also, an average of 30,000 days of LTI (Lost Time Injuries) are registered annually due to work events in the construction sector. In order to illustrate the trends of evolution at the level of the national economy and - respectively - in the economic divisions of the construction activity, we have illustrated in Tables 6 and 7 the values of the main indicators of work accidents occurring in the period 2014-2023 (www.inspectiamuncii.ro). From the centralized data in Table 6, it can be observed that in 2023 in the construction sector there were no collective work accidents, without being able to say, following an analysis of the evolution of this aspect over the years, that it is a trend towards the disappearance of this event type.

Following the evolution of the last three years, a downward trend in the total number of work accidents can be observed in all three branches of the construction field. The same trend also appears when we analyze the evolution of fatal accidents in the field of construction in Romania, in the period 2014-2023.

Table 6. Situation of the injured at work in the field of construction, in Romania. Frequency indices (IF) / Economic divisions

Code div.	Economic division	Number employees	Injured			IF		Collective accidents		
			Total	Fatalities	LTI	Fatalities	Total	No.	Victims	Fatalities
2014										
41	Construction of buildings	166,048	222	21	201	0.13	1.34	1	4	0
42	Civil engineering works	91,623	66	11	55	0.12	0.72	0	0	0
43	Special construction works	118,102	130	11	119	0.09	1.10	2	8	0
2015										
41	Construction of buildings	176,349	308	21	287	0.13	1.88	1	4	0
42	Civil engineering works	79,414	69	7	62	0.07	0.71	0	0	0
43	Special construction works	119,154	96	4	92	0.03	0.82	1	3	0
2016										
41	Construction of buildings	176,149	262	20	242	0.12	1.56	1	4	0
42	Civil engineering works	77,025	96	8	88	0.08	0.93	2	9	1

43	Special construction works	120,605	130	12	118	0.10	1.08	1	3	0
2017										
41	Construction of buildings	172,394	273	19	254	0.11	1.61	3	10	4
42	Civil engineering works	69,431	85	7	78	0.07	0.81	1	3	0
43	Special construction works	120,916	126	8	118	0.06	1.02	0	0	0
2018										
41	Construction of buildings	179,188	268	11	257	0.06	1.42	3	10	1
42	Civil engineering works	65,174	63	6	57	0.06	0.60	1	4	0
43	Special construction works	120,784	111	7	104	0.05	0.87	0	0	0
2019										
41	Construction of buildings	204,871	297	28	269	0.15	1.55	2	6	3
42	Civil engineering works	70,236	80	12	68	0.11	0.71	0	0	0
43	Special construction works	131,901	116	10	106	0.08	0.87	0	0	0
2020										
41	Construction of buildings	224,350	321	24	297	0.12	1.61	2	8	2
42	Civil engineering works	77.673	83	4	79	0.03	0.70	2	8	0
43	Special construction works	141.873	119	7	112	0.05	0.88	1	3	0
2021										
41	Construction of buildings	209.865	268	16	252	0.08	1.29	2	7	3
42	Civil engineering works	121.951	125	14	111	0.11	0.97	0	0	0
43	Special construction works	114.613	131	4	127	0.03	0.94	0	0	0
2022										
41	Construction of buildings	214.166	257	17	240	0.08	1.20	4	12	3
42	Civil engineering works	130.927	127	13	114	0.10	0.97	1	7	4
43	Special construction works	145.882	124	3	121	0.02	0.85	1	3	0
2023										
41	Construction of buildings	227.927	253	11	242	0.05	1.11	0	0	0
42	Civil engineering works	135.714	114	7	107	0.05	0.84	1	5	2
43	Special construction works	150.617	122	3	119	0.02	0.81	1	3	0

Despite the downward trend in the number of deaths in recent years (Figure 3), the construction industry in Romania remains a dangerous activity for workers, in particular, due to the still high number of deaths compared to other branches of activity in the national economy.

Table 7. The main indicators of work accidents occurred in the field of construction, in Romania, in 2023

Activity (CAEN SECTIONS)	**Number of fatally injured**			**Number of non-fatally injured**			**Fatal work accident rate**	**Non-fatal work accident rate**
Construction	**Total**	**Women**	**Men**	**Total**	**Women**	**Men**	**Total**	**Total**
	21	-	**21**	**468**	**16**	**452**	**0.04**	**0.91**
Construction of buildings	11	-	11	242	6	236	0.05	1.06
Civil engineering works	7	-	7	107	4	103	0.05	0.78
Special construction works	3	-	3	119	6	113	0.02	0.79

It can be observed (Figure 4) that the downward trend is maintained even after the years 2020 and 2021 also in the case of the total number of accidents in the field of construction. This fact is largely due to measures specific to the COVID-19 pandemic and post-pandemic periods.

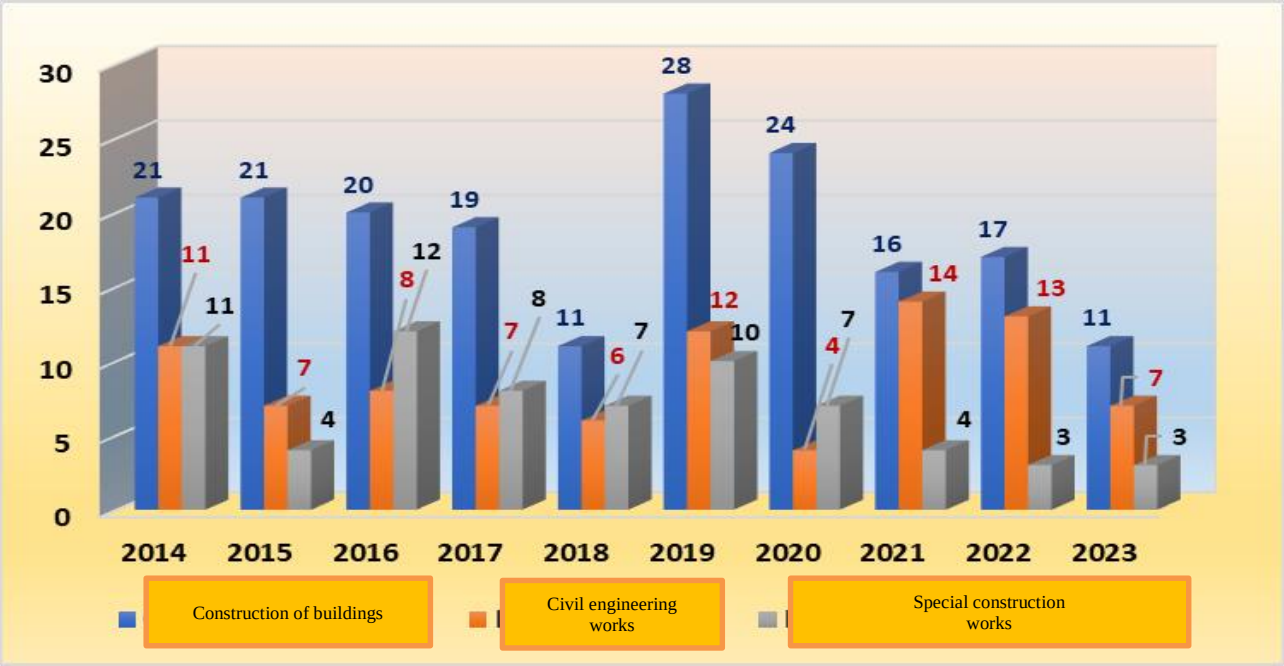


Fig. 3. The evolution of fatal work accidents in the field of construction, in Romania, period 2014-2023

The occupational health and safety situation for workers in the construction sector is extremely worrying. The materialized costs, both in terms of human and financial implications, are considerable, both for society and for the economy. Although the progress made in improving the level of health and safety and working conditions in this sector is significant, efforts must continue. The dynamics of accidents in the sector are determined to a defining extent by the management model [16] and implicitly by the training and information of those responsible as well as all those involved in the project [17]. The undersized organizational structure, specific to most SMEs, together with the deficient integration, or in many cases non-existent, of the prevention component in the company structure, explains the low level of success when analyzing risk management in these types of companies [18].

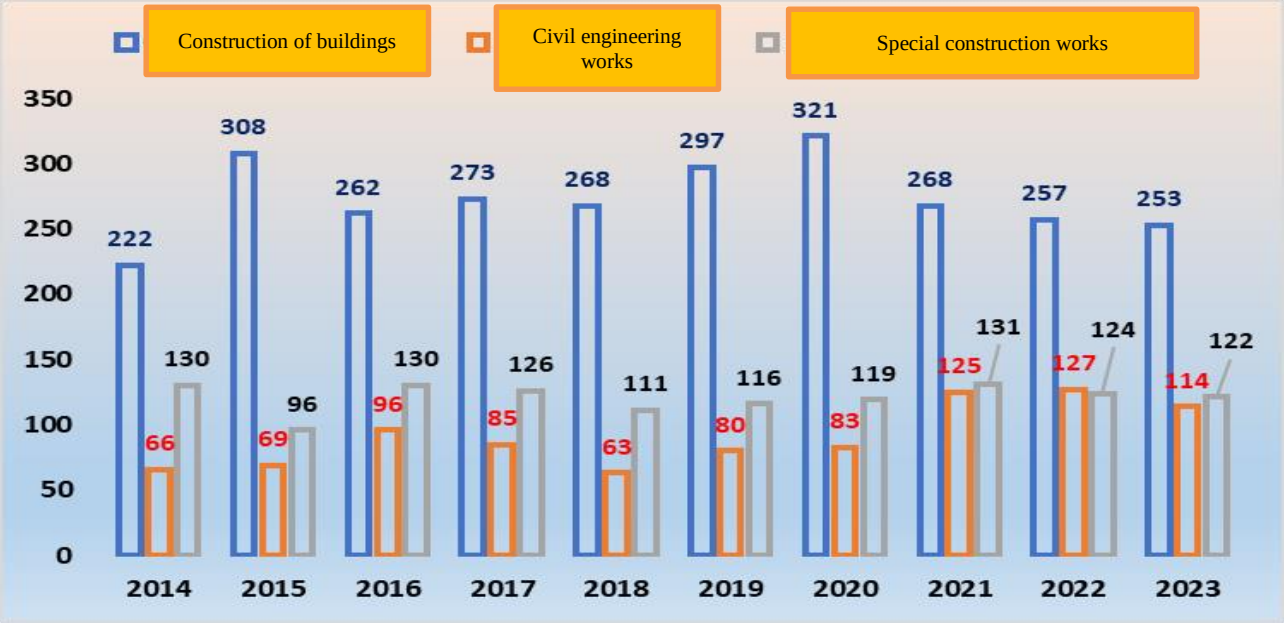


Fig. 4. The evolution of work accidents in the field of construction, in Romania, in the period 2014-2023

5. Risk management strategies applicable in the construction industry

To facilitate the understanding and practical application of concepts, principles, approaches, methods and tools aimed at assessing and managing risks for the safety and health of workers working on temporary or mobile sites, a large number of ***examples and best practices are available.*** There are three major approaches to improving safety in organizations: Safety Management Systems (SMS), Behavior-Based Safety (BBS), and Safety Culture Change Programs. These approaches are not exclusive and, an effective approach advocated by some authors consists of a personalized combination of all three [19]). A brief description of these approaches aims to paint a conclusive picture for practical approaches to OSH management in industry. [20].

a. Occupational Health and Safety Management Systems

Over the last decade, the implementation of OH&S management systems has been recognized as a successful strategy for improving OH&S performance, a recognition expressed – among others – by policies established at European and international level. With these policies as a starting point, OH&S management systems have been continuously developed in numerous companies worldwide. It seems paradoxical, but although OH&S management systems are now routinely implemented by companies, there is still no consensus on the purpose of OH&S management. Certain authors highlight and emphasize the difference between the systematic management of OSH, considered as "*a limited number of principles mandated for the systematic management of OSH, applicable to all types of employers, including SMEs*" and "*the much more complex and highly specific management systems of OSH*" [21].

An important advantage of the OSH management systems approach, highlighted in the ILO working document on the Guidelines for OSH Management Systems, is the integration of OSH into business activities [22].

b. Behavior-Based Safety

Behavioral safety approaches have gained considerable popularity in the industry recently, largely as a result of the multinational company DuPont's well-known "STOP - *Safety Training Observation Program*"). BBS approaches have well-defined stages, including: defining the desired behavior; setting performance goals for predetermined behavior; providing feedback and/or support when goals are met; and, finally, tracking individual and team results over time and publicly displaying the results obtained, in order to achieve an appropriate level of worker motivation [24].

Thus:

- Workers observe each other;
- The observer provides feedback to the observed;
- The observer together with the observed ensures the resolution of problems in order to identify corrective/preventive actions;
- The results of the observations are discussed to identify future actions.

In the Behavioral Safety approach, safety is achieved through ***top-down leadership*** and ***bottom-up commitment***, aiming for an environment where workers care for each other and can speak their minds without retaliation, as well as creating the conditions that encourage people to collaborate in the field of OSH because they want to, not because they have to.

c. Safety Culture change programs

Safety culture programs are the ***latest trend in practical approaches to improving safety management*** [25]. In contrast to BBS approaches, safety culture emphasizes the articulation of safety values, with an approach that primarily involves organizational leaders. There is growing recognition and consensus that understanding safety culture is useful for understanding how organizational leaders influence workers through their behavior and actions [26], [27]

In the case of changing the safety culture, any organizational culture must include safety as a core value in the new structural framework. Furthermore, while the use of safety culture tools is common but questionable, as stated by Zohar [28], [29], **the unique nature of the construction industry requires a personalized and targeted approach to safety management and culture programs**, as has been done globally in the road transport industry, for commercial truck drivers as sole operators [30], [31].

6. Conclusions

The legislation that regulates the field of OSH at the level of each country is based on principles, directions and provisions contained in various normative or advisory acts issued by authorities established worldwide: ILO through guidelines, ISO through standards and at regional level, the European Union through European directives, EU-OSHA through guidelines and guidelines. At the European level, the directive on OSH in the field of construction is transposed through the implementation of the OSH Plan adapted to the legislative specifics of each country.

As a first conclusion, we can note that a simple approach by *complying with the legal requirements in the field of construction does not fully cover the needs of organizing activities specific to the safety and health of workers*. This type of approach is particularly specific to small and medium-sized companies with up to 49 employees.

The OSH plans that are drawn up by specialized personnel, approved by project managers and made available to the authorities, are documents that present *major deficiencies due to the failure to strictly comply with the requirements established by the regulations, both in terms of formal aspects and in the risk assessment process through which all prevention actions must be established*. These plans must contain the planning of prevention activities specific to the works, an aspect that is not always found in this document. The correct assessment of the risks specific to each work within the project, as part of the OSH Plan, thus becomes a foundation of this document.

This raises questions about how such documents are approved without a minimum content analysis to verify their adequacy and are put into practice, as if the mere fact that they exist is enough. Thus, this document is perceived as a simple requirement fulfilled even in the event of an inspection by the competent authorities.

The sense of security thus created is only "fictitious", in reality implying a "serious and imminent risk" to which workers on the site are exposed, without adequate measures and their control. Unfortunately, it is a preventive document to which a rather low value is attributed from an OSH point of view, and a change in its structure is imperative for an efficient adaptation to the reality of the work, even if it would imply modifying the specific existing regulations.

Unfortunately, in Romania, the drafting of the order provided for in art. 12, para. 2, from Law no. 319/2006, through which the obligations of different categories of enterprises were to be established, depending on the nature of the activities and their size, regarding the preparation of several types of documentation, including the documentation aimed at risk assessment. Under these conditions, on a national level, for the realization and documentation of risk assessment, regardless of the field of activity and the size

of the enterprise, the use of the I.N.C.D.P.M. method was practically generalized. Bucharest for assessing the risks of occupational injury and illness. The gradual transition to expanding the range of methods, techniques and tools for risk assessment and analysis is a sine-qua-non requirement in order to increase the effectiveness of the decision-making base for adopting decisions regarding the allocation of resources in order to minimize risks in the construction industry.

At the same time, resorting to the pragmatic, realistic and feasible method of gradually improving the level of security culture (through either top-down or bottom-up approaches) represents a foundation and - at the same time - a guarantee, of the positive evolution of pro-security behaviors and - implicitly - of reducing the probability of occurrence and/or the severity of the consequences of work accidents and occupational diseases. A more complex approach is thus required by including in the specific programs the other three major approaches: *Safety Management Systems (SMS), Behavior-Based Security (BBS) and Safety Culture Change Programs.*

References

[1] **Dregan C.V., Moraru R.I., Popescu-Stelea M., Băbuț G.B.,** 2022
Risk at work: assessment in a Romanian precast concrete elements manufacturing company, Acta Technica Napocensis, Series: Applied Mathermatics, Mechanics and Engineering, vol. 65, 647-658. WOS:000953026700016. https://atna-mam.utcluj.ro/index.php/Acta/issue/view/65

[2] **Kasim H., Hassan C.R.C., Hamid M.D., Emami S.D., Danaee M.** 2019
The relationship of safety climate factors, decision making attitude, risk control, and risk estimate in Malaysian radiation facilities. Safety Science, Vol. 113, pp. 180-191.

[3] **Deepak M.D., Gangadhar M.,** 2019
Review of concepts and trends in safety culture research of construction industry. Indian J Public Health Res Dev. 2019;10(5):148-52. Doi: https://doi.org/10.5958/0976-5506.2019.00985.9

[4] **Byrnes K.P., Rhoades D.L., Williams M.J., Arnaud A.U., Schneider A.H.** 2022
The effect of a safety crisis on safety culture and safety climate: the resilience of a flight training organization during COVID-19. Transp. Policy **117**, 181–191. doi: 10.1016/j.tranpol.2021.11.009

[5] **Moraru R.I., Dregan C.V.** 2023
Developments and perspectives in human factor engineering: a critical analysis, Journal of Research and Innovation for Sustainable Society (JRISS), Volume 5, 5-16. https://doi.org/10.33727/JRISS.2023.2.1:5-16

[6] **Romanian Parliament,** 2006
Legea securităţii şi sănătăţii în muncă nr. 319/2006, Monitorul Oficial al României, Partea I, nr. 646/26.07.2006

[7] **Kim N.K., Rahim N.F.A., Iranmanesh M., Foroughi B.** 2019
The role of the safety climate in the successful implementation of safety management systems. Safety Science, Vol. 118, pp. 48-56. DOI: 10.1016/j.ssci.2019.05.008

[8] **International Labor Organisation**, 2024
Prevention of Occupational Diseases. Retrieved July 13, 2024, from: http://www.ilo.org/safework/events/meetings/WCMS_204594/lang-en/index.htm

[9] **Choudhry R.M., Fang D., Mohamed S.,** 2007
Developing a model of construction safety culture. J Manage Eng. 23(4):207-12. DOI: https://doi.org/10.1061/(asce)0742-597x(2007)23:4(207)

[10] **Choudhry R.M., Fang D., Mohamed S.** 2007
The nature of safety culture: A survey of the state-of-the-art. Saf Sci. 45(10):993-1012. DOI: https://doi.org/10.1016/j.ssci.2006.09.003

[11] **Conchie S.M., Moon S., Duncan M.** 2013
Supervisors' engagement in safety leadership: Factors that help and hinder. Safety Science, 51, 109–117.

[12] **Teperi A.M., Lappalainen J., Puro V., Perttula P.,** 2019
Assessing artefacts of maritime safety culture—current state and prerequisites for improvement. WMU J. Marit. Aff. 18, 79–102. DOI: 10.1007/s13437-018-0160-5

[13] **Kerin T.** 2022
My lessons for process safety leadership. Process. Saf. Prog. 41, 106–110. doi: 10.1002/prs.12296

[14] **Peker M., Doğru O.C., Meşe G.,** 2022
Role of Supervisor Behavioral Integrity for Safety in the Relationship Between Top-Management Safety Climate, Safety Motivation, and Safety Performance. Safety and health at work, 13(2), 192–200

[15] **Tear M.J., Reader T.W., Shorrock S., Kirwan B.,** 2020
Safety culture and power: interactions between perceptions of safety culture, organisational hierarchy, and national culture. Saf. Sci. 121, 550–561. DOI: 10.1016/j.ssci.2018.10.014

[16] **Ramos D., Afonso P., Rodrigues M.A.,** 2020
Integrated management systems as a key facilitator of occupational health and safety risk management: A case study in a medium sized waste management firm. Journal of Cleaner Production, Vol. 262. DOI: 10.1016/j.jclepro.2020.121346

[17] **Stackhouse M., Turner N.,** 2019
How do organizational practices relate to perceived system safety effectiveness? Perceptions of safety climate and co-worker commitment to safety as workplace safety signals. Journal of safety research, 70, 59–69. https://doi.org/10.1016/j.jsr.2019.04.002

[18] **Syed-Yahya S.N.N., Idris M.A., Noblet A.J.,** 2022
The relationship between safety climate and safety performance: A review, Journal of Safety Research, 83(2022)105-118, ISSN 0022-4375, https://doi.org/10.1016/j.jsr.2022.08.008.

[19] **DeJoy D.M.,** 2005
Behaviour change versus culture change: divergent approaches to managing workplace safety. Safety Science, 43(2), 105–129

[20] **DeJoy D., Schaffer B., Wilson M., Vandenberg R., Butts M.,** 2004
Creating safer workplaces: assessing the determinants and role of safety climate. Journal of Safety Research, 35, 81-90

[21] **Flin R.,** 2007
Measuring safety culture in healthcare: a case for accurate diagnosis. Saf. Sci., Vol. 45, pp. 653-667

]22] **Zhou J., Xianbo Z., Zhongmin W., Kendall H.,** 2024
Safety leadership: A bibliometric literature review and future research directions, Journal of Business Research, 172, 114437, ISSN 0148-2963, https://doi.org/10.1016/j.jbusres.2023.114437

[23] **Wang B., Wu C.,** 2019
Safety culture development, research, and implementation in China: an overview. Prog. Nucl. Energy 110, 289–300. DOI: 10.1016/j.pnucene.2018.10.002

[24] **Jana D.K., Pramanik S., Sahoo P., Mukherjee A.,** 2019
Interval type-2 fuzzy logic and its application to occupational safety risk performance in industries. Soft. Comput. 23, 557–567. DOI: 10.1007/s00500-017-2860-8

[25] **Guldenmund F.W.,** 2010
Understanding and Exploring Safety Culture. Doctoral Dissertation, Delft University of Technology

[26] **Dingsdag D.P., Biggs H.C., Sheahan V.L.** 2008
Understanding and defining OH&S competency for construction site positions: Worker perceptions. Safety Science, 46, 619–633

[27] **Dingsdag D.P., Biggs H.C., Sheahan V.L., Cipolla D.J.,** 2006
A Construction Safety Competency Framework: Improving OH&S performance by creating and maintaining a safety culture, Cooperative Research Centre for Construction Innovation, Brisbane: Icon.Net Pty Ltd.

[28] **Zohar D.,** 2010
Thirty years of safety climate research: Reflections and future directions. Accident Analysis and Prevention, 42(5), 1517–1522

[29] **Zohar D.,** 2014
Safety climate: Conceptualization, measurement, and improvement. In B. Schneider & K. M. Barbera (Eds.), The Oxford handbook of Organizational Climate and Culture (pp. 317–334). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199860715.013.0017

[30] **Huang Y.H., Zohar D., Robertson M., Lee J., Garabeti A., Murphy L.** 2012
Development and validation of a safety climate scale for the trucking industry. Proceedings of the international conference on Ergonomics & Human Factors 2012, Blackpool, UK, 16–19 April 2012, pp. 237–241

[31] **Ward D.,** 2022
Creating a Safety Culture on the Jobsite. Occupational Health & Safety. https://ohsonline.com/Articles/2022/12/01/Creating-a-Safety-Culture.aspx?Page=3

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