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CASE STUDY ON IMPROVING OCCUPATIONAL SAFETY AND HEALTH ON CONSTRUCTION SITES

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Abstract:. *This paper presents a case study conducted on 275 workers employed by 4 small and medium-sized construction companies. The 21 influencing factors identified in the study of the causes that generated work accidents were considered. The questionnaire completed by the workers proves that they correctly perceive the major dangers and that they also feel the lack of guidance. At the end of a year of collaboration with the external prevention and protection service and through them with the team leaders, we managed to reduce the accident rate within the four construction companies by 50%, from an average of 6 accidents per year to an average of 3 accidents per year.*
Key words: *Occupational Health and Safety (OHS), Construction, Risk Perception, Accident rate reduction, Continuous safety monitoring.*

1. GENERAL AND SPECIFIC RISKS IN CONSTRUCTION INDUSTRY

The construction sector is a high-risk sector where workers are exposed to a wide range of risks of injury and disease [1].

Labor accidents generally occur through: falling from the same level, involvement in a car accident, electrocution, material impact, falling objects, contact with dangerous substances (acute poisoning, chemical burns), handling of heavy materials, fire, explosion. In addition, specific to construction works are accidents produced by: falling from height, subsidence, burial (during the execution of excavations) [2].

Construction sites are dangerous places where events such as injury, illness or even death of workers can occur. Their cause can be diverse: electrocution, falls from height, injuries caused by tools, equipment and machines, striking by moving construction vehicles, injuries from manual handling operations, diseases caused by dangerous substances such as dust, chemicals etc [3].

The difficulties with recruitment have caused many construction companies to recruit foreign workers, most of them from Asia: India, Pakistan, Sri Lanka. These recruitments populate yards with workers of different religions, different cultures, difficulties in communication and difficulties in adapting these agricultural workers to the highly mechanized industrial environment present on large construction sites. Difficulties in communication are also accentuated by cultural differences, from religion to diet [4].

2. INTERNATIONAL TRENDS AND LITERATURE REVIEW

Several Workplace safety has long been recognized as a fundamental responsibility for organizations, not only from an ethical and regulatory standpoint but also as a vital component of business sustainability [5]. With industrial processes becoming more complex, labor environments more dynamic, and expectations for corporate responsibility higher, there is a pressing need for advancing safety paradigms [6].

With the multidimensional application of artificial intelligence being implemented in new industries, its nascent stages allow for further exploration of new paradigms such as worker safety in the manufacturing industry using these

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advanced technologies. Innovation management offers a promising lens through which safety practices can be rethought and improved. Through integration of new technologies, improved educational and training frameworks, strategic business alignment, and economic planning, organizations can more proactively manage risks [7]. Workplace safety has long been recognized as a fundamental responsibility for organizations, not only from an ethical and regulatory standpoint but also as a vital component of business sustainability. Traditional approaches — based on static procedures, compliance checklists, periodic training, and reactive incident reporting—are often ill-suited for the rapid pace of change seen in many sectors today [8].

Innovation management offers a promising lens through which safety practices can be rethought and improved. Through integration of new technologies, improved educational and training frameworks, strategic business alignment, and economic planning, organizations can more proactively manage risks [9].

Safety management has historically relied on compliance, standard operating procedures (SOPs), checklists, inspections, and periodic training. While these are necessary, they tend to be reactive—focusing on past incidents—and struggle with anticipating new or evolving risks (e.g., those introduced by new machines, human factors, or even pandemics).

The role of innovation management in safety innovation management involves generating, selecting, and implementing new ideas, processes, or technologies in alignment with organizational strategy. Applying innovation to safety implies shifting from reactive to proactive risk management, continuous improvement, and embedding safety culture. Key dimensions include technological innovation, process innovation, organizational and managerial innovation, and educational innovation [10].

AI and computer vision: Recent case studies show how AI and vision systems monitor compliance (PPE usage), detect zone intrusions, analyze behaviors, and issue alerts in real time. This can significantly reduce incident rates. For example, a heat & power facility using AI-powered monitoring saw reductions in safety alerts and higher PPE compliance [11].

Predictive analytics: The shift toward predictive risk modeling uses historical data and machine learning to forecast accidents or near misses before they happen. For example, predictive analytics in occupational health and safety literature from India demonstrates how data-driven proactive interventions outperform reactive safety protocols [12].

Immersive Virtual Reality (VR) / Immersive training: VR-based safety training has gained traction. Empirical studies show that immersive VR training improves hazard recognition, proper use of PPE, ability to identify safety violations, and retention of knowledge compared to traditional methods. For example, a construction engineering study reported improvements of ~14% in correct PPE usage and ~29% in hazard scenario recognition among trainees, especially novices. Also, studies on confined space VR training show improvements in safety behavior and reduced error rates [13].

Safety culture, continuous learning, leadership commitment, behavioral safety (e.g., safety behavior prediction models), and human factors (personality, cognition, fatigue) play important roles. Research into how personality traits influence safety behavior among construction workers shows non-linear relationships and suggests models to predict unsafe behavior before incidents occur [14].

Safety improvements incur costs (technology acquisition, training, maintenance), but evidence shows that benefits (reduced accident costs, lower insurance premiums, higher productivity, less downtime) often outweigh those costs. Moreover, integrating safety innovations aligns with corporate sustainability reporting, stakeholder expectations, and regulatory compliance, contributing to long-term business viability.

An automotive-sector case in Romania evaluated how adopting *Smart Manufacturing Integrated Systems (SMISs)* and *Cyber-Physical Systems (CPSs)* introduced new risks but also new safety safeguards. Ergonomic and cognitive strain from human-machine interaction and cybersecurity were addressed

through predictive maintenance, real-time monitoring, and traceability [15].

Construction workers (novices vs. experienced) in a study of immersive virtual reality safety training showed significant improvement in hazard recognition and PPE selection, especially among novices [16].

A study on confined space VR training using the Kirkpatrick model found positive effects on knowledge transfer, reduction in execution time, fewer errors, improved safety behaviors.

In medical settings (radiation settings), a randomized crossover trial showed VR training reduced exposure significantly compared to traditional didactic training; also increased confidence, engagement, satisfaction [17].

The study "*Intelligent Approaches to Predictive Analytics in Occupational Health and Safety in India*" discusses using machine learning and statistical modeling to forecast risks, enabling pre-emptive interventions [18].

This study rigorously evaluates the AI models that have been used, the manufacturing industries that have benefited, the case studies, the policies, and their gray areas, and how AI can compensate for the inadequacies of the policies and standards that are currently implemented. Through the analysis, it is evident that AI has become a critical enabler in advancing occupational safety, hazard detection, and predictive maintenance across diverse manufacturing sectors. Through the integration of ML, computer vision, and real-time monitoring systems, AI offers to enhance operational efficiency and worker safety while also allowing us to address the gaps in regulatory compliance and possibilities to compensate for the weak implementation of occupational safety and health policies and standards. However, AI serves as a powerful tool to bridge policy shortcomings and optimize safety practices. The current laws do not incorporate AI-related clauses that regulate its usage and avert any adversarial usage within the manufacturing industry. This study highlights the need for harmonizing AI integration with existing safety standards, fostering worker trust through transparent human–AI collaboration and ensuring continuous model improvement through feedback from real industrial scenarios [19].

Another study looked at predictive modeling of work accidents using lagging safety indicators to modernize social security frameworks; integrating proactive digital tools was advocated [20].

The personality-safety behavior predictive relationship, using neural networks, shows how understanding individual differences can help target safety interventions [21].

3. OSH AT WORK: PRACTICAL SOLUTIONS AND PREVENTION MEASURES IN CASE OF SPECIFIC HAZARDS

The "*construction sector*" is a high-risk field in which workers are exposed to a wide range of hazards that may cause accidents and illness. On the one hand, there are general risks also present in other fields of activity: mechanical, electrical, physical, chemical, biological, ergonomic, and psychosocial risks. On the other hand, there are risks specific to the field, arising from working outdoors—exposed to the elements—near massive machinery (trucks, bulldozers), at the base of earth banks when reinforcing a foundation or installing sewage systems, or working at heights during various phases of constructing different structures [22].

Construction sites are dangerous places where events such as injury, illness, or even death of workers can occur. The causes are diverse: electrocution, falls from height, injuries caused by tools, equipment, and machinery, being struck by moving construction vehicles, injuries resulting from manual handling operations, and illnesses caused by hazardous substances such as dust and chemicals. The absence of collective protections in work areas at height, working in excavations with unsupported walls, or performing tasks on incomplete scaffolding or on their exterior are activities with a particularly high level of risk.

The difficulties employers face in recruiting personnel negatively affect site discipline. They often prefer to tolerate workers not wearing personal protective equipment for various

trivial excuses fearing employees might quit if stricter discipline is enforced.

The same recruitment challenges have led many construction companies to hire foreign workers, mostly from Asia: India, Pakistan, Sri Lanka. These recruitments populate worksites with workers of different religions and cultures, with communication difficulties and adaptation challenges. Communication issues are further exacerbated by cultural differences, from religion to dietary restrictions.

In the apparent absence of insurance companies' involvement—who should complement the supervision of health and safety norms on construction sites alongside labor inspectors and the safety coordinators appointed by the client—the role of ensuring safety should be taken over by the safety culture of the teams on site.

An effective risk management process encourages a construction company to identify and quantify risks and to consider risk-limiting and risk-reducing policies. Construction companies that manage risks effectively enjoy optimized financial results and higher productivity, improved success rates for new projects, and better decision-making processes [23].

The risk-management framework for construction projects can be improved by combining qualitative and quantitative methodologies with risk analysis. That is why we must emphasize the educational role of the team, as team members are far more attentive to workplace discipline when the safety culture is deeply rooted in the collective subconscious. It is necessary to point out that in constructions the specific hazards that are also those with the most tragic consequences are that of burial and that of falling from a height. Identified in various studies, the risk factors that caused accidents on construction sites were grouped into four categories:

i. Human factor's own risk factors, caused by: behavior and attitudes, health status, lack of experience, training and educational gaps.
ii. Risk factors of the means of production which may be caused by defects or non-conformities of work equipment.
iii. Risk factors specific to the work environment caused by inadequate working conditions represented by inadequate lighting, improper working surface, unfavorable weather.
iv. Risks related to the working task.

In order to control and counter these risks, there must be a convergence of the efforts made by participants in the process of implementing occupational safety and health: the management of construction companies through the implementation of a safety culture at work, the health and safety coordinators and the representatives of on-site management in the person of designated workers.

Another major factor in increasing work safety that would be able to contribute to the achievement of the proposed objective – the prevention of work accidents – may be, as in other states (e.g., England, Germany) insurance company. Through their specific work, they actively participate in the organization of yards by assessing the situation before the insurance policy is concluded, imposing compliance with labor security standards, and applying consistent penalties in case of non-compliance with occupational safety and health rules consisting of an increase in the value of the insurance premium (bonus malus), followed by regular visits for risk inspections during the insurance contract. These are prerequisites designed to ensure better prevention in the field of accidents at work.

Last but not least, the safety instructions that are used to define the working mode are factors with an important role of reducing the risk of accidents. An organized activity of designing procedures for each process would be much more effective.

4. CASE STUDY: RESARCH GOALS AND METHODOLOGY

In order to improve the security climate in the small and medium-sized enterprises operating in the construction field, we intend to diagnose with a questionnaire the current state of OSH culture in these organizations, which will provide us with a reference point from which we can increase the level of safety of

jobs. The collection of data on the technical-social systems and the implementation of occupational safety and health systems starts from the evaluation of a factual situation and finding solutions. In this sense, knowing the opinions of those directly involved is important. The questionnaire designed to identify the impact of some factors on occupational safety and health conditions. In order to relate to the current situation of work-related accidents at national level, we draw from the statistics published by the Ministry of Labor and Social Solidarity information on the work-related accidents produced in the first quarter of 2023 [24].

In the first quarter of 2023, 1,068 people were injured, 153 less than in the same period of 2022, of which 4 were fatally injured. The frequency index (the number of accidents per 1,000 workers) was 0.76/00 for all injured people and 0.003/00 for fatal accidents. The evolution of fatal accidents categorized by sectors of activity highlights the high rate of accidents in construction. Accident analysis from the point of view of seniority at work reveals that 69.6%, that is 743 people of the total number of accidents are workers up to 5 years old (18.4%, that is, 197 injured people, have seniority at work between 1-3 years), and those in the age group 5-10 years, in the number of 145 people, represent 13.6% of the total accidents.

From the same source we find out that statistically the dependent causes of the executor that generated over 75% of the work accidents in the first quarter of 2023 were:

- Improper performance of work operations;
- Falls from the same level or height;
- non-use of means of individual protection, failure to carry out timely operations indispensable to the safety of work;
- exposure to dangerous or harmful factors (travel, stay in places or areas with temporary or permanent danger).

Work load-dependent causes – shortcomings in the performer's work load generated the production of 752 accidents, representing 70.4% [24]:

- omissions in the pre-establishment of work operations;
- lack of safety and health at work;
- improper distribution of performers on jobs;
- errors in the pre-settlement of work operations;
- deficiencies in guidance, supervision and control.

Thus, from the presented statistical data, we deduce that the factors that played an important role in the production of work accidents are:

i. seniority in work;
ii. improper planning and performance of work operations;
iii. non-use of PPE;
iv. failure to carry out operations which are indispensable to occupational safety in a timely manner;
v. access to high-risk areas;
vi. improper distribution of performers on jobs;
vii. deficiencies in guidance, supervision and control.

Starting from these data, we want to create a set of questions to analyze the perception of workers and to propose ways to improve compliance with occupational safety and health rules at construction sites in order to eliminate or at least reduce the number of work accidents. Closely related to the factors that played an important role in the production of accidents at work, we have developed a set of statements that edify the perception of workers through the score given by them in the questionnaire, in order to define a set of measures and corrective approaches.

- ***Seniority at work***:

a) Seniority in occupation
b) Seniority at work

- ***Inadequate planning and performance of work operations***:

- Discussing how to approach before operations start (discussions on what to do and what safety procedures should be followed for these operations);
- Training at work
- The existence and information of its Instructions;
- Training of workers before entering a new construction site on the hazards specific to the activity and location.

-***Not using the Individual Protection Equipment***

a) Prohibition of access to the construction site to those who do not wear personal protective equipment

b) The use of personal protective equipment by job managers to give an example of conduct

c) The use of personal protective equipment throughout the working day

- Failure ***to carry out work safetty operations in a timely manner***

a) Stabilization of excavation banks in order to avoid subsidence over workers

b) Mounting of collective protections at workplaces at height (railings, platforms or catch nets to prevent falling from a height)

c) Periodic verification of the proper functioning of the work equipment

d) Verification of the electrical installation of the construction site and the grounding connection before the start of work

- ***Access to areas of high hazard***

a) Inspection of scaffolds before allowing access to workers

b) The execution of an operation in a high-risk area (on the outside of the scaffolding, in excavation with unsupported banks, at the angle without visibility of the user of a heavy machine) should be avoided even if the intervention is short-term

- ***Improper distribution of performers on jobs***

a) Avoiding crowding of work platforms by overlapping multiple teams

b) The operation of machinery (cranes, bulldozers, voles) only by those authorized

- ***Deficiencies in guidance, supervision and control***

a) Supervision of workers at height and those who carry out activities in excavated areas in order to avoid accidents

b) Appointing a person to supervise and guide new employees on the construction site

c) The visit of the site by the OSH specialist in order to identify and eliminate hazards that may cause accidents at work

d) Immediate communication of identified hazards (defective work equipment, lack of collective protection, improperly fitted scaffolding, other hazards) in order to avoid accidents that may result from them

The research has a dual purpose, informative and predictive. This means that on the one hand the employee recognizes a situation, and on the other hand expresses a desire to improve a given situation. Each worker grades from 1 to 5 depending on the importance it has the risk factor presented has in his acceptance. The interpretation of the results was carried out subsequently applying different hypotheses and statistical analysis procedures. A higher score means increasing the importance of the analyzed factor for occupational health and safety. The planning is done taking into account the level of risk, the attackability of the risk and risk treatment options available. The collection of data on the technical-social systems and the implementation of occupational safety and health systems starts from the evaluation of a factual situation and starts the process of searching for solutions. In this sense, knowing the opinions of those directly involved is important. The questionnaire designed to identify the impact of some factors on occupational safety and health conditions.

This set of questions, distributed to workers in small and medium-sized enterprises in the field of construction, has a dual role, informative and predictive. This means, on the one hand, that the employee is aware of a situation, and on the other hand expresses his desire to improve a situation which is often overlooked, being considered unimportant by the decisive factors.

4. RESULTS AND DISCUSSION

The study involved 275 workers employed in 4 small and medium-sized construction companies. The 21 factors of influence identified from the study of the causes that caused accidents at work were considered. Respondents appreciated the importance of working in health and safety of factors by giving points from 1 to 5. Among the 275 questionnaires we removed those that had answers that were inconsistent with the requirements, 31 of them having answers with „yes/no” and 15 were incomplete.

Various hypotheses and statistical analysis procedures were subsequently applied to interpret the results of the questionnaire. An increased score denotes the importance for occupational health and safety given by workers to the factor under consideration. The questionnaire responded according to the requirements of the statement 229 workers; in order not to distort the responses through possible external interference, the questionnaires were distributed for completion by the workers of the external health and safety services during the meeting for the annual assessment of the appropriation of knowledge in the field of occupational safety and health. The questionnaires were not nominal and the workers didn't sign it.

Factors statistically identified as having a major role in the causal chain of occurrence of labor events were noted with F1 - F 21. These factors were assessed by the participants in the questionnaire with scores from 1 to 5, 1 for low importance and 5 for high importance. The surveyed workers are workers in small and medium-sized enterprises in the construction sector, are not from the management echelon and do not have higher education. Representatives of external occupational safety and health services collected questionnaires and centralized the results. The primary statistical analysis consisted of the following: summation of the points granted, calculation of the average, dispersion, median, confidence (ratio between dispersion and average – expressed in percentage).

Following the study, the following hierarchy of factors of influence was obtained:

1. The task of work by properly planning and performing work operations, the so-called „toolbox talk", that is, discussing how to approach before the start of operations (discussions about what to do, in what order and what safety procedures should be observed for these operations)

2. Improper distribution of the personnel on the workplaces by operating the machinery (cranes, bulldozers, voles) only by the authorized ones.

3. Also in the field of distribution of tasks by avoiding the agglomeration of work platforms due to the overlap of several teams on the same working front.

Workers seem to feel the lack of explicit indications of how to deal with different working procedures and the need to recall the correct order of execution of complex operations in the yard before the execution of the work.

Not unimportant are the causes behind the last ranked factors, showing hidden dangers, factors that can generate accidents, ignored by the workers in the studied yards:

- interdiction of access to the construction site for those who do not wear personal protective equipment
- the execution of an operation in a high-risk area (on the outside of the scaffolding, in excavation with unsupported banks, in the angle of visibility of the user of a heavy machine) must be avoided even if the intervention is short-lived
- check the electrical installation of the construction site and the grounding linkage before the start of work

For the chosen research, it is hypothesized that the score given by the respondents completely describes the issue of occupational safety and health. Thus, the relevance of their response is 100%. The responses of the workers were influenced by the age of the respondents, that is, by their work experience. In terms of education the majority are with 10 or more graduated classes, none of them having higher education. Age-related maturity seems to make a difference in the case of hazard reporting and occupational safety and health rules. The respondents are aged between 20 and 55 years, with 135 workers aged 20 to 35 years, 53 workers aged 36 to 45 years and 41 workers aged 46 and over. The highest scores were given by those in the middle-aged category, with the youngest and the oldest apparently being more superficial in terms of occupational safety and health rules and regulations. When asked questions about the reason behind the answers, young people do not perceive danger due to lack of experience and older people develop a higher risk tolerance due to prolonged exposure to high-risk working conditions.

5. CONCLUSION

Following the analysis of the data obtained by interviewing the workers, we notice that the majority have taken seriously the questionnaire, out of the total of 275 surveyed workers only 46 did not understand the request, and from the correctly completed questionnaires it is clear from the re-evaluation of the scores granted as a percentage that the ranking order is kept, that is, the survey requirements were correctly explained and well understood. In order to meet the expectations of workers, companies working in the field of construction should take into account their fears, namely:

- discuss the safety procedures of the daily operations, to remember the steps needed to be taken and eliminate the subsequent omissions;
- to prevent the operation of machinery by unauthorized persons, persons who are not aware of the security procedures imposed by the nature of such procedures;
- to plan judiciously the order of operations on the construction site, using specific tools (Gantt Chart or equivalent) so that the working platforms do not turn into chaotic sites, where members of different teams fight for access to the working front.

The questionnaire completed by the workers proves that they correctly perceive the major hazards and that they also feel the lack of guidance. A collaborative approach is therefore required from those involved in the management of the site and those who ensure compliance with the safety and health rules.

The introduction of so-called „toolbox talk" discussions before work starts and the supervision of workers who carry out activities in high-risk and specific areas can save many lives in the long run, being obviously justified by the gain of security of work on construction sites.

The work task is crucial to be well explained and the procedures that compose it to be remembered before the start of the work.

Safety and health instructions are processed in the course of training by external occupational safety and health services or by managers on a quarterly or monthly basis, but the message is often lost until the procedures are put into practice. The solution is to review these procedures before starting work with the help of team leaders and to supervise workers during operations to ensure the correct order of operations and the implementation of procedures without omissions of security measures. Another approach implemented to reduce the incidence rate of accidents on construction sites was the development of a guide for occupational health and safety audits, designed to facilitate the work of managers in small and medium-sized construction enterprises in our country.

In practice, to implement the occupational health and safety audit in the enterprises covered by this study, two audit stages were used: one for the enterprise—reviewed every six months—and one for the construction site, where interventions were made whenever new observations were recorded during site visits, for reporting nonconformities or near-miss incidents. The enterprise audit includes verifying the legality of the company's operations, the authorization of machinery requiring certification, and the authorization of trades that require such verification. The audit conducted through site visits includes checklists related to the safety and health of the workers on the construction site: verification of scaffold assembly, verification of the support of excavation walls, or checking whether workers are using personal protective equipment.

At the end of one year of collaboration with the external prevention and protection service and through them with the team leaders, we managed to reduce the accident rate within the four construction companies by 50%, from an average of 6 accidents per year to an average of 3 accidents per year.

The cost in time and money was small compared to the result obtained, managing not only to halve the number of accidents at work, but also to raise the level of professional training of workers, who are now making far fewer accident-generating mistakes, but also to strengthen discipline on the construction site and improve the safety climate within teams. The experiment was successful, reducing the

incidence of work accidents on construction sites by half, being a remarkable result in terms of occupational safety and health. Even if ideally, it would be the elimination of accidents, in a dangerous environment like the one on the construction site with heavy machinery on the move, with high jobs and busy work platforms.

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Studiu de caz privind îmbunătățirea securității şi sănătății în muncă pe şantierele de construcții

Rezumat:. *Această lucrare prezintă un studiu de caz realizat pe 275 de lucrători angajați la 4 firme de construcții mici și mijlocii. Au fost luați în considerare cei 21 de factori de influență identificați în studiul cauzelor care au generat accidente de muncă. Chestionarul completat de lucrători dovedește că aceștia percep corect pericolele majore și că resimt și lipsa îndrumării. La sfârșitul unui an de colaborare cu serviciul extern de prevenire și protecție și prin intermediul acestora cu șefii de echipă, am reușit să reducem rata accidentelor în cadrul celor patru firme de construcții cu 50%, de la o medie de 6 accidente pe an la o medie de 3 accidente pe an*

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