STATISTICAL ANALYSIS OF WORKPLACE ACCIDENTS AND RISKS IN THE ADVERTISING PRODUCTION SECTOR (2010–2025)

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Abstract *This paper presents a statistical and comparative analysis of occupational accidents, incidents, and occupational diseases in the advertising production sector and related industries in Romania over the period 2010–2025. Although advertising activity itself has a relatively low incidence rate of accidents, related activities—such as printing, material processing, and outdoor installation—involve significant occupational risks. The study integrates data provided by the Labour Inspectorate and the National Institute of Statistics, as well as Eurostat, to identify trends, risk typologies, and determining factors. The results highlight a transition from mechanical hazards toward chemical and technological risks, underlining the need to adopt modern prevention strategies and digital training solutions.*

Keywords: occupational safety and health, advertising production, accident statistics, risk analysis, Industry 4.0, Pareto analysis

1. INTRODUCTION

The advertising production sector has experienced accelerated growth over the past two decades, driven by digitalization and the integration of Industry 4.0–specific technologies. This evolution has led not only to an increase in activity volume, but also to a diversification of the technological processes involved—from conventional printing and material processing to the use of CNC equipment, laser technologies, and UV printing systems [1], [2].

In this context, occupational safety and health (OSH) becomes particularly important, as the profile of occupational risks has changed significantly. While in the past mechanical hazards predominated—associated with traditional machinery (guillotines, presses)—there is currently a growing presence of emerging risks, such as exposure to volatile organic compounds (VOCs), UV radiation, or ultrafine particles generated by cutting and printing processes [3], [4].

Although advertising activity in the strict sense (design, marketing) involves a low risk of occupational injury, related sectors—especially printing houses, material-processing workshops, and outdoor installation activities—entail a significant level of occupational risk. These activities are characterized by the intensive use of mechanical and electrical equipment, the handling of chemical substances, and the performance of work at height [1], [5].

Statistical analyses of workplace accidents in these domains indicate that, although the frequency rate is relatively low compared with industries such as construction, accident severity

can be high, including cases of permanent disability or prolonged temporary incapacity for work [2], [3]. In addition, the specialized literature points to an increasing trend in respiratory and ergonomic occupational diseases, associated with prolonged exposure to chemical agents and the use of digital equipment [4].

At the European level, data provided by Eurostat through the ESAW system allow the comparison of occupational safety indicators and highlight the need to harmonize prevention measures across Member States [3]. In Romania, institutions such as the Labour Inspectorate and the National Institute of Statistics ensure the collection and reporting of relevant statistical data, forming the basis for risk analyses and the development of prevention policies [1], [2].

The aim of this paper is to conduct a statistical analysis of workplace accidents and occupational diseases in the advertising production sector and related fields for the period 2010–2025, focusing on: identifying evolutionary trends in safety indicators; determining the main types of accidents and associated causes; and highlighting emerging risks generated by new technologies. The results contribute to substantiating modern prevention strategies based on the integration of digital technologies and on adapting OSH training to the new realities of the industrial environment.

2. METHODOLOGY

This chapter describes the methodological framework used to analyze workplace accidents and occupational risks in the advertising production sector and related fields. It presents the data sources used, the criteria applied to select them, and the statistical and analytical methods employed to process and interpret the information. The adopted approach combines a quantitative analysis of safety indicators with modern risk assessment methods, thereby ensuring a sound scientific basis for the results obtained.

2.1. Data sources and analytical foundation

The analysis presented in this study is based on official data sources recognized at both national and European levels, ensuring the accuracy, comparability, and relevance of the results. Integrating these sources enables a multidimensional assessment of occupational risks in the advertising production sector and its related domains. The main data sources used are:

Labour Inspectorate (Inspecția Muncii) – the institution responsible for monitoring and reporting workplace accidents at the national level. The annual reports provided include detailed information on the number of accidents, their severity, causes, and distribution across economic sectors according to the CAEN classification.

National Institute of Statistics (Institutul Național de Statistică) – through the TEMPO Online database (series ACC101A and ACC102A), it provides statistical indicators regarding the number of injured workers, their structure by sex, age groups, and activity domains, as well as trends over time.

Eurostat – through the ESAW system (European Statistics on Accidents at Work), it provides standardized indicators at European level, facilitating comparisons between Romania and other EU Member States.

The selection of these sources was based on criteria of credibility, timeliness, and relevance to the analyzed domain. Moreover, the simultaneous use of national and European data enables validation of results and their interpretation within a broader context.

2.2. Defining the scope of analysis

Because advertising activity (CAEN 7311) primarily involves office-based work with

relatively low occupational risk, the analysis was extended to related sectors involved in the production of advertising materials, namely:

- printing houses (CAEN 1812);
- processing of plastic and metal materials (CAEN 222, 251);
- outdoor installation activities (installation of billboards, metal structures, lighting systems).

This approach enables a more realistic capture of the occupational risks associated with the entire advertising production chain.

2.3. Data processing methodology

The methodology used in this study is mixed, combining quantitative and qualitative methods, as follows:

a) Descriptive statistical analysis. This was used to determine the time evolution of workplace accidents, identify their distribution by type and cause, and compute frequency and severity indicators. Data were aggregated for the period 2010–2025, and for 2024–2025 estimates were used based on trends identified in historical series.

b) Pareto analysis (80/20). To identify the main causes of accidents, the Pareto principle was applied, according to which a small number of factors generate the majority of effects. This method enabled the prioritization of risks and provided a basis for developing prevention strategies.

3. RESULTS AND CONCLUSIONS

This chapter synthesizes the results of the statistical analysis of workplace accidents and occupational risks in the advertising production sector and related fields for the period 2010–2025. It highlights trends in the evolution of frequency and severity indicators, the typology of accidents, and the determining factors, followed by a critical interpretation in the context of technological and organizational transformations. The discussion enables the correlation of the findings with the specialized literature and supports the formulation of directions for improving occupational safety and health.

3.1. Evolution of workplace accidents during 2010–2025

The analysis of workplace accident trends in the advertising production sector and related domains reveals a complex dynamic influenced both by technological progress and by economic and organizational factors.

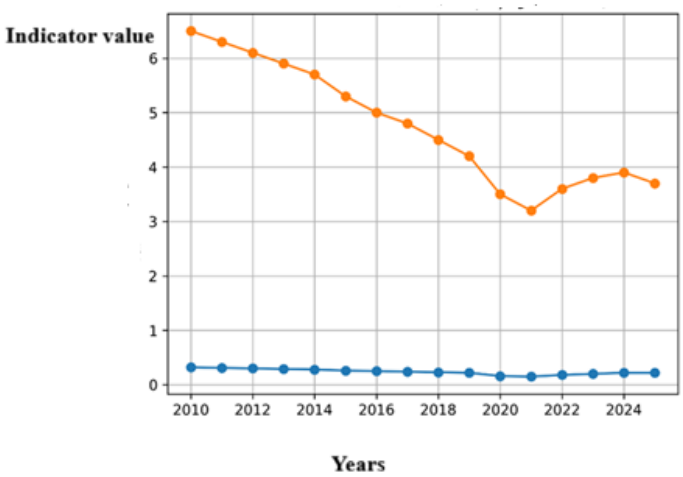

Figure 3.1. Trends in frequency and severity indicators (2010–2025)

Based on data provided by the Labour Inspectorate and the National Institute of Statistics, four main stages can be distinguished in the evolution of occupational safety indicators (Fig. 3,1).

The first stage, corresponding to the 2010–2014 interval, is characterized by a high level of the severity index, primarily driven by the use of outdated technological equipment. During this period, many companies in the printing and advertising production sector relied on second-hand machinery, often lacking modern protective systems such as presence sensors or light curtains. As a result, serious mechanical accidents—especially cuts and crush injuries to the upper limbs—occurred frequently and generated a substantial number of days of temporary work incapacity. In addition, inadequate maintenance and technical improvisations further contributed to an increased risk of injury.

The second stage, 2015–2019, marks a period of accelerated equipment modernization, largely supported by access to European funds and alignment with European Union safety standards. The introduction of CNC technologies, large-format printers, and automated systems led to a significant reduction in severe mechanical accidents. However, this technological transition also shifted the risk profile, with an observed increase in incidents associated with exposure to chemical substances, especially volatile organic compounds (VOCs). Moreover, the expansion of the outdoor advertising segment contributed to a rise in falls from height, highlighting the importance of adequate training for work performed under special conditions.

The 2020–2022 period represents a statistical anomaly, driven by the impact of the COVID-19 pandemic on economic activity. The imposed restrictions led to a significant reduction in production and installation activities, which was reflected in an artificial decrease in the number of reported accidents, estimated at approximately 25–30%. At the same time, there was an increase in ergonomic and psychosocial risks generated by telework and intensive use of digital equipment; however, these are less well captured by traditional workplace accident statistics.

The final stage, 2023–2025, highlights a stabilization of the frequency index around 0.20–0.22 accidents per 1,000 workers, accompanied by a decrease in accident severity. This trend confirms the positive effect of automation and the implementation of technological safety measures. Nevertheless, a diversification of risks can be observed, particularly through incidents associated with the use of modern technologies such as laser systems and UV printing. These include exposure to radiation, emissions of fine particles, and fire hazards, which—although less frequent—require a specific approach within occupational safety and health management systems.

In conclusion, the evolution of workplace accidents over the analyzed period reflects a transition from traditional mechanical hazards to more complex technological and chemical risks. This shift requires the adaptation of prevention strategies and the development of training programs oriented toward new types of hazards, in line with the requirements of modern industry.

3.2. Typology of Workplace Accidents in the Advertising Production Sector

The typological analysis of workplace accidents in the advertising production sector and related fields highlights a significant diversity of events, driven by the complexity of technological processes and the variety of equipment used. Accidents can be classified into several main categories, each associated with specific risk factors.

The most frequent category of accidents consists of cuts and crush injuries, mainly associated with the use of guillotine cutters, industrial cutters, and finishing equipment (laminators, presses). These accidents predominantly affect the upper limbs—especially fingers and palms—and are caused by the absence of protective systems or improper equipment use. In many cases, they lead to temporary work incapacity, but they may also result in permanent disabilities, particularly in cases of partial amputation.

A second important category is falls from height, specific to outdoor installation activities. Installing billboards, mesh banners, or illuminated structures involves working on scaffolding, ladders, or aerial work platforms, often under difficult conditions (wind, unstable surfaces, proximity to electrical networks). These accidents occur less frequently than mechanical ones, but they have a high degree of severity and are often associated with serious or fatal injuries.

The category of chemical accidents includes acute or chronic intoxications caused by inhalation of solvent vapors used in printing and screen-printing processes. Substances such as isopropanol or methyl ethyl ketone are commonly encountered in advertising production workshops and may cause respiratory disorders, mucosal irritation, or neurological effects in cases of prolonged exposure. These risks are amplified in unventilated spaces or in environments insufficiently equipped with air filtration systems.

In addition, electrical accidents are also present, generated by the use of high-power equipment or unauthorized interventions on electrical installations. Particularly during the installation of illuminated advertising systems, there is a risk of contact with high-voltage networks, which can lead to electrocution or severe burns.

Another relevant category is represented by mechanical trauma associated with material handling, such as large rolls used in printing or rigid panels made of metal and plastic. Improper handling of these materials can cause crush injuries, impacts, or physical overexertion, contributing to the development of musculoskeletal disorders.

In the context of recent technological evolution, the emergence of new risks associated with modern technologies—such as UV printing and laser cutting—can also be observed. These include exposure to UV radiation, fire hazards, and inhalation of ultrafine particles resulting from the processing of composite materials. Although the frequency of such accidents is relatively low, their long-term impact on workers' health can be significant.

In conclusion, the typology of accidents in the analyzed sector reflects a transition from traditional mechanical risks to more complex chemical, electrical, and technological risks. This diversification requires an integrated occupational safety and health approach, including both technical protective measures and training programs adapted to the new working conditions.

3.3. Pareto Analysis of the Causes of Workplace Accidents

To identify the main determining factors of workplace accidents in the advertising production sector and related domains, a Pareto analysis was applied, based on the 80/20 principle. According to this principle, a small number of causes generate most of the effects, which enables efficient prioritization of prevention measures. The analyzed data, processed based on reports provided by the Labour Inspectorate, highlight an uneven distribution of accident causes. The results show that:

- Cuts and crush injuries associated with the use of cutting machinery account for approximately 45% of total accidents;

- Falls from height, specific to outdoor installation activities, contribute approximately 25%;
- Manual material handling generates approximately 12%;
- Exposure to chemical substances accounts for about 8%;
- Electrical and thermal accidents total approximately 6%;
- Other causes (trips, slips, etc.) have a smaller share, about 4%.

The cumulative analysis indicates that the first two categories—cuts/crush injuries and falls from height—generate approximately 70% of total accidents, confirming the applicability of the Pareto principle in the analyzed domain.

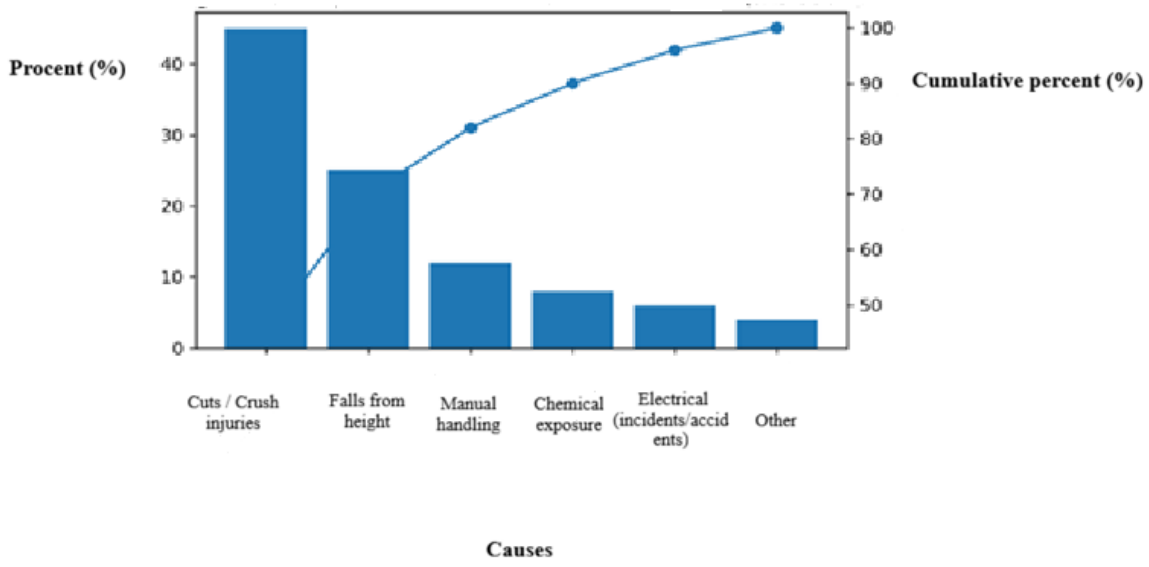

Figure 3.3. Pareto chart of the causes of workplace accidents (dual-axis representation)

The obtained results indicate that the dominant risks are primarily associated with two types of activities: operating cutting equipment and working at height. These activities involve both technical factors (hazardous equipment) and human factors (operational errors, insufficient training).

From a risk management perspective, this concentration of causes enables the formulation of highly effective prevention strategies. Accordingly, allocating resources to reduce risks associated with these two categories can lead to a substantial decrease in the total number of accidents.

In the case of cutting machinery, prevention measures should focus on:

- implementing automatic safeguarding systems (sensors, light curtains);
- standardizing operating procedures;
- periodic training of operators.

With regard to installation activities performed at height, emphasis should be placed on:

- the use of collective and personal protective equipment (harnesses, lifelines);
- personnel certification;
- planning and supervision of the work.

A relevant aspect highlighted by the Pareto analysis is that, although technology has reduced the frequency of severe mechanical accidents, it has not eliminated the associated risks entirely. Instead, a tendency toward risk "redistribution" has been observed toward other categories, such as chemical and electrical risks.

This observation confirms the existence of a phenomenon known in the specialized literature as the "technological safety paradox," according to which increasing automation can lead to reduced operator vigilance and, consequently, to the maintenance of a relatively constant level of accidents caused by human error.

The Pareto analysis confirms that most accidents in the advertising production sector are generated by a limited number of causes, which creates an opportunity to implement targeted and effective measures. Focusing on critical areas (cutting machinery and work at height) is key to significantly reducing occupational risks.

3.4. Emerging risks in the context of Industry 4.0

The rapid evolution of technologies used in the advertising production sector—particularly in the context of Industry 4.0—has led to the emergence of new types of occupational risks, referred to in the specialized literature as "emerging risks." These are characterized by a high degree of uncertainty, limited visibility, and a significant potential impact on workers' health, especially over the medium and long term.

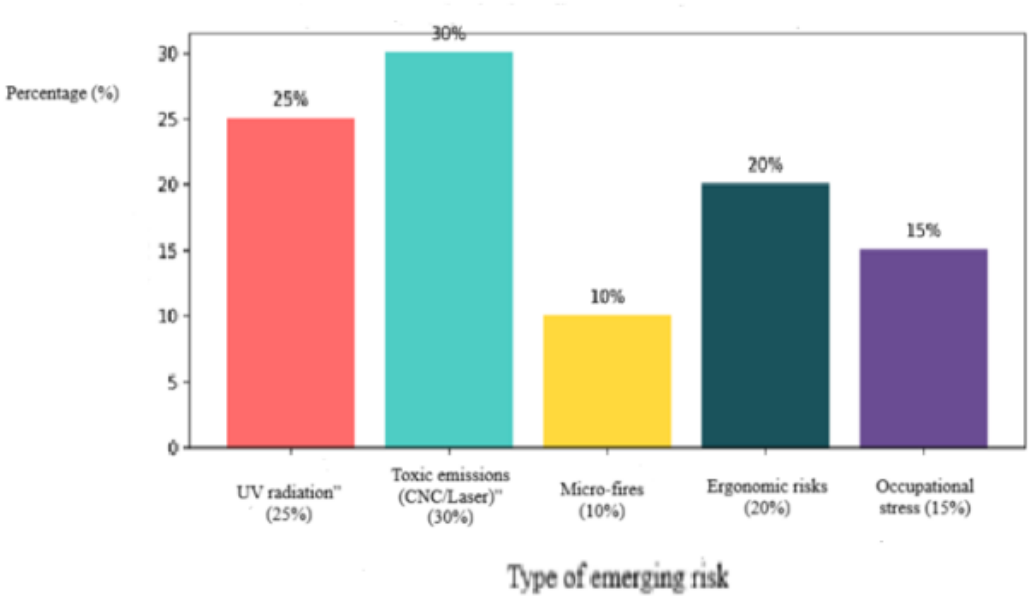

Figure 3.4. Distribution of emerging risks in the advertising production sector

A first type of emerging risk is exposure to UV radiation, specific to the use of UV-LED printing systems. These machines are increasingly common in advertising production due to their efficiency and high print quality. However, direct or indirect exposure to UV radiation can cause eye disorders (photokeratitis) and skin lesions, especially in the absence of adequate protective systems or when safe working procedures are not followed. The risk is amplified by

operators' tendency to underestimate the hazard, perceiving these technologies as "safe" because of their high level of automation.

A second type of emerging risk is associated with toxic emissions and ultrafine particles generated during CNC and laser cutting processes. Materials frequently used in advertising—such as PVC, acrylic (plexiglass), or metal composites—can release toxic vapors and microscopic particles during processing. Without effective ventilation and filtration systems (e.g., HEPA-type filtration), these contaminants can affect workers' respiratory systems. Repeated exposure to such agents may lead to chronic occupational diseases that are difficult to diagnose in the early stages.

Another relevant risk involves small-scale fires ("micro-fires") that may occur during the operation of laser or CNC equipment. These incidents are generally caused by incorrectly set operating parameters, the accumulation of dust or flammable material residues on the work surface, and the lack of continuous process monitoring. Although most of these events do not result in major accidents, they indicate vulnerabilities in control systems and may escalate into serious situations in the absence of appropriate preventive measures.

In addition to physical and chemical hazards, there is also a growing presence of ergonomic and psychosocial risks, driven by digitalization and an intensified work pace. Prolonged use of computer equipment in design and prepress activities can lead to musculoskeletal disorders (carpal tunnel syndrome, lower-back pain) as well as visual fatigue. At the same time, deadline pressure and the need to adapt rapidly to new technologies can generate occupational stress and reduced concentration capacity, thereby increasing the likelihood of human error.

An important aspect of emerging risks is their "invisible" nature, which makes awareness and management within organizations more difficult. Unlike traditional risks that are easy to identify (for example, the hazard posed by a guillotine cutter), emerging risks require advanced monitoring and assessment methods, such as environmental sensors, air-quality analysis systems, or digital tools for evaluating occupational stress.

In conclusion, integrating modern technologies into the advertising production sector does not eliminate occupational risks; rather, it transforms them by introducing hazards that are less visible but potentially significant in impact. This reality necessitates the development of proactive prevention strategies based on continuous training, real-time monitoring, and adapting occupational safety and health management systems to new technological conditions.

The study results highlight a structural transformation of the risk profile in the advertising production sector, characterized by a shift from traditional mechanical risks to emerging chemical and technological risks.

4. CONCLUZION

The statistical analysis of workplace accidents and occupational diseases in the advertising production sector and related fields in Romania for the period 2010–2025 highlights a series of significant transformations in the occupational risk profile, driven primarily by technological evolution and organizational changes in the work environment.

First, the results indicate a general trend toward a reduction in accident severity, reflected by a decrease in the severity index. This development correlates with equipment modernization and the implementation of more effective technological safeguarding systems, such as proximity sensors, light curtains, and automatic shut-off systems. However, the frequency index

did not decrease proportionally, suggesting that the human factor remains a decisive contributor to accident occurrence.

Second, the typological analysis confirms that traditional mechanical hazards still account for a substantial share of accidents, particularly in relation to cutting and finishing machinery. At the same time, an increase in emerging risks is observed, associated with modern technologies such as UV printing and laser cutting. These introduce new types of exposure—including radiation, fine particle emissions, and toxic vapors—which are not always captured by conventional accident statistics, yet may have significant long-term effects on workers' health.

A relevant outcome of the study is the confirmation of the applicability of the Pareto principle. It shows that a limited number of causes—mainly cuts/crush injuries and falls from height—generate the majority of accidents. This finding has direct implications for resource allocation within occupational safety and health management systems, suggesting that interventions should be concentrated on critical areas.

The comparative analysis with other industrial sectors also indicates that, although the advertising production sector has a lower accident rate than fields such as construction, risk complexity is increasing, especially due to the diversification of technologies and processes involved. In this context, "invisible" risks—such as exposure to chemical substances or adverse environmental factors—are becoming increasingly relevant.

Another important aspect highlighted by the study is the impact of external factors, such as the COVID-19 pandemic, which produced an artificial decrease in the number of reported accidents, alongside an increase in ergonomic and psychosocial risks. This situation underscores the need to expand the OSH approach beyond physical accidents toward an integrated perspective on occupational health.

In conclusion, the research results demonstrate that the transition to advanced technologies does not eliminate occupational risks, but rather transforms them, requiring continuous adaptation of prevention strategies. In this regard, the study recommends developing training programs tailored to new technologies, integrating digital solutions (virtual reality, real-time monitoring), improving working conditions through effective ventilation and protection systems, and strengthening the organizational safety culture.

Through an integrated approach to risks and the use of modern analytical methods, the advertising production sector can evolve toward a sustainable model in which economic performance is aligned with a high level of occupational safety and health.

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