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Implementation of Digital Solutions in Occupational Safety and Health in Romania: Comparative Analysis, Legal Framework, and Official Data

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Abstract. In the context of the accelerated digital transformation across the European Union, the field of occupational safety and health (OSH) in Romania faces major challenges regarding the integration of modern technologies into risk prevention processes and legislative compliance. Although national regulations have allowed digital OSH training since 2022 (Government Decision no. 259/2022), the large-scale adoption of these solutions remains limited, particularly among small and medium-sized enterprises (SMEs) (European Commission, DESI 2023). This article provides a comparative analysis of traditional and digital methods for managing OSH activities in Romania, with a focus on training, auditing, reporting, and document traceability. The advantages of digital tools—such as electronic signatures, cloud archiving, mobile applications, and analytical dashboards—are discussed in contrast with the limitations of physical systems. The conclusions emphasize the need for a strategic digitalization plan for OSH, based on European best practices, investments in digital infrastructure, and the development of digital skills among occupational safety and health professionals.

Keywords: safety, health, digital solutions, legal framework

1. Introduction

The transformations brought by digitalization across all economic sectors of the European Union have had a considerable impact on labor policies, including the field of occupational safety and health (OSH). While industries such as IT, banking, or automated manufacturing rapidly adopt digital solutions, OSH often remains dependent on traditional methods—face-to-face training, paper-based documentation, physical archives, and reactive procedures (EU-OSHA, 2022).

In Romania, this gap is even more pronounced. According to the DESI 2023 (Digital Economy and Society Index) report, Romania ranks last among European Union member states in terms of integrating digital technologies into business processes. Only 11% of SMEs use ERP software and less than 8% adopt cloud solutions for document management and operational workflows (European Commission, 2023). These figures reflect a systemic issue that also affects activities related to preventing workplace accidents and occupational diseases. At the same time, the legislative framework has partially modernized. Government Decision no. 259/2022 explicitly allows OSH training to be conducted digitally, with electronic signatures and cloud archiving. Furthermore, Law no. 319/2006 clearly stipulates obligations regarding employee training, risk assessment, and information—processes that can be significantly optimized through digital technologies. These changes pave the way for a profound transformation of OSH management activities.

The need for modernization is also supported by external pressures. In a recent report, the European Agency for Safety and Health at Work (EU-OSHA, 2022) highlighted the advantages of immersive virtual reality (VR) training, mobile applications for incident reporting, and the use of artificial intelligence for predictive risk analysis. Such solutions have the potential to enhance legal compliance, reduce accidents, and foster a culture of prevention, in line with international standards such as ISO 45001:2018**.** Against this backdrop, this article aims to:

- provide a comparative analysis of traditional and digital methods used in OSH activities in Romania;
- evaluate the legislative framework and the current level of digitalization compared to field realities;
- highlight relevant statistical data on workplace accidents and the potential impact of digitalization;
- propose strategic development directions for the field, based on European best practices.

By integrating official data and applying a rigorous methodology, this article seeks to contribute to a better understanding of the challenges and opportunities brought by the digitalization of OSH processes in Romania, providing a scientific foundation for future policies and technological solutions.

2. National Context of OSH Digitalization

In Romania, the field of occupational safety and health (OSH) is regulated by a robust legal framework, largely aligned with European directives. However, the integration of digital solutions into prevention, training, and auditing activities remains fragmented and insufficiently structured at a systemic level.

2.1. Legislative Framework

The main regulatory act governing OSH in Romania is Law no. 319/2006, also known as the "Law on Occupational Safety and Health." This law transposes Council Directive 89/391/EEC on measures to improve the safety and health of workers at work. The law establishes employer obligations regarding: risk assessment; employee training; continuous information and implementation of preventive measures. A significant step towards digitalization was made through Government Decision no. 259/2022, which explicitly regulates the possibility of conducting OSH training online, with electronic signatures on documents and digital storage. This change has created the legal foundation for the implementation of digital platforms in the field, reducing dependence on physical archives and mandatory in-person attendance. Furthermore, digitalizing processes involves the processing of certain categories of personal data. Thus, compliance with Regulation (EU) 2016/679 (GDPR) is essential when implementing applications, online platforms, surveillance cameras, or cloud solutions, in order to ensure the confidentiality of employee data.

International standards also provide a basis for harmonizing digitalization practices:

- ISO 45001:2018 – the international occupational health and safety management system, which allows digital integration of risk assessment, monitoring, and continuous improvement;
- ISO/IEC 27001:2022 – the standard for information security management, applicable to digital OSH platforms.

2.2. National Digitalization Status

According to the DESI 2023 (Digital Economy and Society Index) report, Romania ranks last in the EU for "integration of digital technology in business":

- only 11% of SMEs use ERP software;
- only 8% use cloud solutions (European Commission, 2023).

In terms of OSH, there is not yet a specific national indicator for digitalization in this field. However, the low adoption rate of electronic signatures and the predominant use of paper-based forms indicate a low level of digital maturity. Moreover, according to an analysis by EU-OSHA (2022), Romania is not among the EU member states that use advanced digital tools (VR, AI, mobile apps) at an institutional scale for occupational safety activities.

2.3. Intermediate Conclusions

Even though the legislative framework allows for the digitalization of OSH activities and international standards support digital integration, Romania is still at an early stage in terms of practical implementation. The main causes identified are:

- lack of IT infrastructure in many enterprises;
- organizational resistance to change;
- lack of digital training among OSH specialists;
- absence of dedicated governmental initiatives for digitalization in this field.

3. Comparison Between Traditional and Digital Methods in OSH Activities

The digital transformation of occupational safety and health (OSH) involves moving from paper-based administrative processes and physical interaction to automated IT solutions that offer electronic traceability, remote access, and digital archiving.

3.1. Traditional Methods – Characteristics and Limitations

The classical methods used in Romania include:

- periodic face-to-face training;
- physical signing of individual training records;
- storing documents in physical archives;
- reporting incidents on paper or verbally;
- OSH inspections and audits through planned visits and manual checks.

These methods are characterized by:

- high consumption of time and human resources;
- increased risk of document loss or deterioration;
- difficulties in managing large volumes of information;
- lack of data traceability and centralization.

According to a report by EU-OSHA (2021), approximately 42% of small enterprises in Europe consider the lack of administrative resources to be a major obstacle in maintaining OSH documentation in a traditional format (EU-OSHA, 2021).

3.2. Digital Methods – Functionalities and Benefits

Digitalization in OSH involves adopting the following solutions:

- online and video training, with automatic validation;
- qualified electronic signature;
- cloud-based management of training records;
- mobile applications for real-time incident reporting;
- dashboards for analyzing risk data and corrective measures.

According to EU-OSHA (2022), the use of digital tools for training reduces administrative costs by up to 70% and increases compliance rates among employees by 60% compared to classical methods.

3.3. Comparative Table – Traditional vs. Digital Methods in OSH, in table 1.

Table 1. Traditional vs. Digital Methods in OSH.

OSH Activity	Traditional Method	Digital Solution	Estimated Benefit (%)
Employee training	Physical presence, handwritten signature	Online platforms, video + electronic signature	-60% time
Document archiving	Physical files, storage space	Secure cloud, controlled access	-80% storage space
Incident reporting	Written forms, delayed submission	Mobile apps, instant alerts	-50% response time
Internal audits and control	Planned visits, paper spreadsheets	Automated dashboards, PDF export	+65% efficiency
Traceability of measures	Manual follow-up	Digital history, automated notifications	+75% clarity

Source of comparative estimates: EU-OSHA (2021, 2022), *Digitalisation and OSH*; ISO 45001:2018; documented analysis in [Martin, 2021].

3.4. Observations

The implementation of digital technologies not only streamlines OSH processes but also contributes to:

- reducing non-compliance risks during ITM inspections;
- improving the prevention culture through constant feedback;
- lowering indirect costs (materials, time, involved personnel).

Additionally, digital solutions can easily integrate legislative updates, automatic notifications, and e-learning features for employees, contributing to a modern, dynamic, and up-to-date OSH system.

4. Results and Discussions

To understand the potential impact of digitalization in the field of occupational safety and health (OSH), it is essential to analyze statistical data on workplace accidents in Romania and their evolution over recent years. This section provides an evaluation of persistent risks, correlated with the low level of digitalization, and an interpretation of the potential benefits offered by integrating modern technologies.

4.1. Evolution of Workplace Accidents in Romania (2020–2022)

According to official data published by the Labour Inspectorate (ITM) and processed by the National Institute of Statistics (INS), the evolution of workplace accidents in Romania is as presented in fig.1.

Figure 1. Figure example.

Source: Labour Inspectorate, Statistical Bulletins 2020–2022; INS, TEMPO database on workplace accidents.

4.2. Observations and Interpretation

Although the total number of accidents did not increase significantly during the analyzed period, there is a persistent annual average of over 3,400 cases, of which approximately 120 are fatal accidents. This stagnation indicates a plateau in the effectiveness of traditional prevention measures.

The most affected sectors in 2022 were:

- Construction – 19% of total accidents;
- Transport and storage – 16%;
- Metal processing and heavy industry – 13%.

These sectors share common factors:

- high operational risk;
- a significant number of field workers;
- a low level of digital integration, particularly in SMEs (EU-OSHA, 2022).

4.3. Potential Impact of Digitalization – Documented Estimates

According to the EU-OSHA (2022) report and a comparative analysis conducted by ILO (2021):

- the use of mobile applications for risk reporting leads to a 25–35% reduction in response time;
- digital training, enhanced with interactive modules, increases information retention among employees by up to 60%;
- automated OSH audits reduce document preparation time by up to 70%, based on pilot implementations in Germany and France.

These data confirm that digitalization contributes not only to administrative efficiency but also to reducing human risk through:

- rapid feedback;
- tracking the implementation of measures;
- real-time data collection.

4.4. Discussions

The stagnation in the number of accidents in Romania reflects the limits of the current system, which remains largely dependent on reactive, paper-based processes, without real-time alert tools or automatic traceability.

Digital integration is not a comfort option but a strategic necessity:

- in high-risk sectors (construction, logistics, industry);
- in the context of increasingly strict European regulations;
- to protect both employers and employees.

Additionally, digitalization can facilitate the collection of valuable data for public policies, risk reduction strategies, and national prevention campaigns.

5. Challenges and Limitations of OSH Digitalization

Although the benefits of digitalization in occupational safety and health (OSH) are undeniable—enhanced efficiency, traceability, and real-time monitoring—the implementation process remains challenging for many organizations, especially in Romania. This section highlights the main technical, legislative, cultural, and financial obstacles faced by companies attempting to adopt digital solutions in OSH.

5.1. Technical and Infrastructure Limitations

One of the most common impediments is the lack of adequate IT infrastructure. According to a report by the National Research and Development Institute for Labour Protection "Alexandru Darabont" (INCDPM, 2022), in over 50% of the SMEs surveyed, OSH management systems were not digitized at all, and internet connectivity in production areas was limited.

Particularly in sectors such as construction, agriculture, and transportation, the implementation of digital solutions is hindered by:

- lack of stable networks on construction sites or isolated industrial areas;
- absence of compatible mobile equipment (tablets, scanners, sensors);
- incompatibility with existing ERP systems.

5.2. Legislative and Ethical Challenges

The use of monitoring applications (including wearables and biometric sensors) raises a series of legal issues related to data protection. Under Regulation (EU) 2016/679 – GDPR, employee monitoring must be proportionate and comply with the principles of legality and transparency.

Key difficulties include:

- lack of specific regulations on data collection from OSH applications;
- divergent interpretations by labour inspectors regarding the use of electronic signatures on OSH records;
- employee reluctance toward continuous digital surveillance (EU-OSHA, 2022).

5.3. Resistance to Change and Cultural Barriers

Technological implementation is not only an infrastructure issue but also a matter of mindset. In many cases, middle-aged or older management prefers traditional methods, perceiving technology as a risk factor or source of uncertainty.

According to a study published in Safety Science (Starren et al., 2020), over 40% of European employees over 50 years old show reluctance toward using digital applications in prevention activities.

5.4. Initial Costs and Lack of Funding

Although digitalization brings long-term savings, the initial costs (software licenses, staff training, equipment purchases) are high. In Romania, the lack of dedicated funding schemes for OSH digitalization causes many companies to postpone investments.

Example:

During the POCU 2014–2020 session, Axis 6.5 on improving working conditions did not explicitly include OSH digitalization, focusing instead on professional training (Ministry of European Funds, 2020).

5.5. Fragmentation of the Digital Solutions Market

Currently, the OSH digital solutions market in Romania is fragmented, with few specialized developers. The absence of a certification framework for applications leads to:

- solutions that are incompatible with Romanian legislation;
- applications that do not offer complete traceability;
- lack of integration between training, audit, and reporting modules.

This problem can be mitigated through standardization and digital accreditation initiatives at the Ministry of Labour or in partnership with INCDPM.

5.6. Examples and Partial Conclusions, table 2.

Table 2. Partial Conclusions.

Identified Challenge	Description	Estimated Impact	Recommended Solutions
Lack of IT infrastructure	Unstable networks, lack of mobile equipment, poor cloud access	45% lower adoption rate in SMEs	Investments in infrastructure via EU funds (PNRR, POCIDIF)
Legislative ambiguity (e-signature, GDPR)	Lack of clear regulations for digital documents and monitoring	35% of companies avoid digitalization	Legal clarifications from ITM and dedicated OSH digital standards
High initial costs	Initial investments in licenses, training, equipment	Only 18% of firms use digital OSH tools	Subsidies for digitalization, tax incentives
Cultural resistance	Reluctance to adopt technology, especially employees >50 years	2 out of 5 employees reject digital training	Continuous training and technological coaching
Lack of certified suppliers	Unaccredited apps lacking full traceability and legal integration	60% use partially compliant solutions	Certification of apps by specialized institutions

Source of estimates: EU-OSHA (2022), INCDPM (2022), Starren et al. (2020), Ministry of European Funds (2020).

6. Conclusions and Future Directions

The digitalization of activities in the field of occupational safety and health (OSH) is no longer merely a technological option but a strategic necessity for modern organizations, particularly in the context of evolving international standards and the increasing pressure to optimize risk prevention processes.

This study has demonstrated, through the comparative analysis of traditional and digital methods, that technological solutions can bring significant benefits in terms of traceability, response speed, and reduction of human errors. At the same time, the official data analyzed (INS, ITM, INCDPM) reveal a concerning reality: Romania lags far behind the European average in terms of OSH digitalization, with a low implementation rate, especially among SMEs and in high-risk sectors.

Key conclusions:

- Digital solutions can reduce incident reporting time by over 50% and can improve internal audit efficiency by over 60% (Starren et al., 2020; INCDPM, 2022).
- The main obstacles to implementation are poor infrastructure, legislative ambiguities, and the lack of a digital organizational culture.
- Digital training and mobile applications could become the standard for continuous worker education, provided that clear regulations and dedicated funding are in place.

Future directions for research and action:

1. Standardizing digital OSH applications
   The Ministry of Labour, in collaboration with INCDPM, should develop accreditation criteria for digital solutions so that companies can select applications that comply with Romanian legislation.
2. Funding digitalization through European funds
   Integrating OSH digitalization into PNRR, POCU, and POCIDIF programs could support implementation in poorly digitized sectors. At present, these areas are only marginally reflected in the official funding guidelines.
3. Integrating artificial intelligence in risk prevention
   The next step in digitalization involves using machine learning algorithms for predictive incident analysis based on historical data and real-time risk indicators.
4. Developing an ethical framework for employee monitoring
   With the increasing use of biometric sensors and mobile monitoring applications, it is necessary to develop a robust ethical and legal framework in line with GDPR.
5. Creating a national network of best practices for digital OSH
   Technical universities, software companies, labour inspectorates, and OSH specialists can collaborate on a national platform for experience sharing, solution testing, and improving the digitalization process.

In conclusion, digitalization in OSH is a complex but inevitable process. The coherent and responsible implementation of technology, along with legislative adaptation and continuous personnel training, can lead to a safer, more efficient working environment that meets the demands of the 21st century.

References

Online versions of all reference lists will, wherever possible, be linked electronically using CrossRef. Consequently, it is *vitally* important for all the references to be accurate and to be carefully formatted using the guidelines below, enabling your paper to be available online with the minimum of delay. There should be a 5 mm gap between the reference number (e.g., '[1]') and the start of the reference text. Second and subsequent lines of individual references should be indented by 5 mm.

Examples:

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