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DIGITIZATION OF OCCUPATIONAL HEALTH AND SAFETY PROCESSES: DESIGN AND IMPLEMENTATION OF AN INTEGRATED SOFTWARE MODULE

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Abstract: This article presents the design of an integrated software module developed for the digitization of occupational health and safety (OHS) management processes, in accordance with Romanian legislative requirements. Microservices-based architecture enables API integration with HR and DMS systems, while electronic signatures ensure the legal validity of documents. The software module covers personnel management, training planning, qualification monitoring, accident reporting, and automatic generation of internal decisions, assisting users with real-time notifications. Testing in three pilot companies revealed a 96% reduction in document issuance time and an 82% decrease in non-compliance cases. The results demonstrate that OHS digitization is not merely a technological upgrade, but an operational necessity that directly enhances safety, efficiency, and organizational sustainability.

Key words: Digitization; Occupational Health and Safety; Risk Management; Compliance; Software Development; Electronic Signature.

1. INTRODUCTION

In the context of ongoing industrial development and process digitization, the need for a better control over operations and working conditions becomes essential. Organizations face major challenges related to operational efficiency, employee safety, and rapid adaptation to technological changes. In this regard, the development of an integrated system for planning and optimizing operational processes, combined with a monitoring mechanism for workplace system components, represents a modern and effective solution.

The main goal of this initiative is to create an intelligent digital platform that enables not only the coordination and streamlining of internal processes but also the prevention of injury risks through active monitoring of working conditions. The use of emerging technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and real-time analytics systems contributes to transforming the

workplace into a safer, more predictable, and more productive environment.

Contemporary companies operate in a dense regulatory landscape, where occupational health and safety (OHS) obligations require exhaustive records, traceability, and rapid reporting. Traditional methods such as physical files, handwritten logs, fragmented processes, generate inefficiencies and expose organizations to financial and reputational risks. This article presents a concrete digitization project centered on a software module that automates core OHS processes and provides a unified view of compliance.

2. METHODOLOGY

The methodology used for the development of the integrated software module followed a three phased design methodology approach: (i) Requirements Elicitation and Analysis, (ii) Iterative Design and Implementation, and (iii) Validation in real organizational environments.

The goal was to build and evaluate a technological solution to a clearly defined problem in this case, the fragmentation and inefficiency of Occupational Health and Safety (OHS) processes in Romanian organizations.

First, we conduct a literature search in a major database, Web of Science, using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework [1]. Search words used: digitization of OSH processes, integrated software module.

One of the issues identified in literature is that digitalization introduces new and amplifies existing hazards, requiring innovative solutions [2]. As work styles evolve with technology, OHS risks also change, raising safety, ethical, and privacy concerns [3]. Monitoring systems may cause stress and anxiety, while factors like performance pressure, reduced social interaction, prolonged work without breaks, and physical strain can affect mental and physical health [4]. Remote work increases OHS responsibilities, demanding closer support for workers. Employers must adopt regulations, monitor changing risks continuously, and address emerging hazards proactively [5].

From our literature search we found that there are few software solutions that aim to improve the management of OSH in the workspace [6].

A challenge for digitization of OSH processes is that some commercially available solutions demand additional financial resources for implementation and customization [7].

The methodology used for the development of the integrated software module followed a three-phased design methodology approach: (i) Requirements Elicitation and Analysis, (ii) Iterative Design and Implementation, (iii) Validation

The first phase, Requirements Elicitation and Analysis, involved gathering functional and non-functional requirements through:

- *OSH legislation analysis.* Law 319/2006 and Government Decision 1425/2006 were reviewed to map mandatory processes such as training, medical supervision, reporting, and recordkeeping [8].
- *Stakeholder interviews.* Structured interviews and workshops were conducted with OHS officers, HR managers, and IT administrators

from three pilot companies to identify desired functionalities [9].

- *Process mapping.* Existing workflows were diagrammed (training, incident reporting, internal decisions) to identify compliance gaps [10]. This stage resulted in a prioritized list of features, performance criteria, and integration requirements (e.g., electronic signatures, GDPR compliance).

The second phase, Iterative Design and Implementation, for system design we used a modular, microservices-based architecture to ensure scalability, configurability, and ease of integration with existing systems. Key design elements included: *Architecture blueprinting* with definition of service boundaries (Personnel, Training, Incident Management, Authorization Management), *Security and Compliance Model*, and *Integration Framework*. In this phase we integrated emerging technologies such Machine Learning, IoT data ingestion and qualified electronic signatures. We also decided on implementation approach - technology stack, functional prototypes, security testing.

In the third phase, Validation and Pilot Testing, a pilot module was implemented in three companies from different sectors (manufacturing, logistics, services). It was elaborated as an evaluation framework based on performance metrics, user feedback and compliance audit simulation.

A Continuous Improvement process was pursued based on pilot feedback and new functions were added. Also, the iterative cycle of “design - evaluate – refine” will continue as the module will scales to additional organizations.

3. APPLICATION DESCRIPTION

The digital transformation of Occupational Health and Safety (OHS) processes is a crucial step for any organization aiming to be efficient, compliant, and prepared for future challenges. In a constantly evolving economic and legislative environment, digitization is no longer an optional competitive advantage but a fundamental requirement for operational and legal sustainability.

This paper aims to explore the development and implementation of such an integrated

system, presenting its architecture, key functionalities, benefits for companies and employees, and its impact on improving work processes.

Law 319/2006 and Government Decision 1425/2006 establish strict obligations regarding training, medical supervision, event reporting, and record-keeping. Inspections by the Territorial Labor Inspectorates (ITM) frequently reveal archiving errors, expired documents, and unplanned training sessions. The absence of a centralized system leads to delays and additional costs. A scalable, secure, and easily configurable digital solution becomes essential for continuous monitoring and rapid compliance auditing.

The proposed integrated system is designed to cover several fundamental functions in a modern industrial environment: Workflow automation (training, decisions, reporting); Use of electronic signatures for document validation; Electronic archiving with controlled access; Automatic report and alert generation; Full traceability of actions and responsibilities.

The paper presents research on the complete digitization of OHS processes through:

- Automation of OHS workflows from collecting personnel data to incident reporting
- Increased legal compliance, real-time monitoring, proactive alerts, and automatic document generation
- Traceability and remote access, web-mobile interface, qualified electronic signature, tamper-proof history

Scalability and configurability adaptable to companies of any size and sector-specific requirements.

3.1 Technical Architecture and Platform

In today's context of accelerated digitization and increasingly strict labor law requirements, automating OHS processes has become a necessity for modern organizations. Manual management of OHS-specific activities such as employee training, monitoring of protective equipment, medical check records, or incident management, not only consumes time but also increases the risk of human error and legal non-compliance. In this context, the design of a dedicated software module for automating core

OHS processes aims to streamline activities in this field while ensuring traceability, transparency, and compliance with current legislation. The module will facilitate data centralization, automatic generation of reports and notifications, and the implementation of a system for tracking the company's legal and internal obligations.

Key stages in designing such a software module include defining functional and non-functional requirements, outlining the modern system architecture, and detailing its interaction with users and other IT components of the organization (infrastructure, technology stack, API integration, security). Infrastructure: Dedicated servers in Tier III data centres in Romania (in compliance with data residency requirements), geographic replication, and encrypted backups. Technology stack: Python 3.10, PostgreSQL 15, Redis cache, Docker containers orchestrated via Kubernetes on Azure Stack HCI; file storage on S3-compatible object storage. API Integration: Bidirectional REST/JSON interfaces with HR systems (e.g., SAP SuccessFactors, Charisma) for syncing personnel data, job roles, organizational charts, and "hire-to-retire" events. Security: TLS 1.3, AES-256 encryption at rest, OAuth 2.0/OIDC for authentication, periodic penetration testing, GDPR and eIDAS compliance

3.2 Main Functionalities

A modern monitoring and management system must offer more than basic data collection. It must ensure proactive intervention, adaptability, and efficient integration with existing technological ecosystems. The following are the essential functionalities that define the performance and added value of this type of system:

Centralized Personnel Management, including automatic import of data from HR systems (Fig. 1); updates triggered by changes in job role, status, or work schedule; digital recordkeeping of medical files, certifications, qualifications, and special authorizations; alerts at multiple configurable thresholds (30, 7, 1 days) for expiration or non-compliance.



Fig. 1. Automatic Data Import

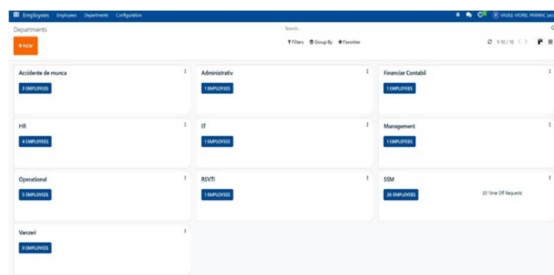


Fig. 2. Role Definition

Title	Category	Status	Last Update
Alert	Administrativ	Active	2024-06-03 10:00
Accident de muncă	Administrativ	Active	2024-06-03 10:00
Administrativ	Administrativ	Active	2024-06-03 10:00
Finanțiar Contabil	Administrativ	Active	2024-06-03 10:00
Management	Administrativ	Active	2024-06-03 10:00
Operational	Administrativ	Active	2024-06-03 10:00
SSM	Administrativ	Active	2024-06-03 10:00
Verificator	Administrativ	Active	2024-06-03 10:00

Fig. 3. Alerts

Modeling the OHS organizational structure

- Definition and review of roles (OHS officer, workers' representative, workplace supervisor, emergency response team (fig. 2).
- Automatic validation of the competencies required by legislation for each role.

Internal decision management includes:

- Customizable templates, sequential/ parallel approval workflows, electronic signature, and versioned archive
- Alerts when designated individuals leave the company or change roles (Fig. 3)

Communication and acknowledgment proof includes Push/email/SMS notifications to all affected employees; Electronic signature on the information form; 100% coverage reports to confirm acknowledgment by all recipients



Fig. 4. Electronic Signature on the Information Form

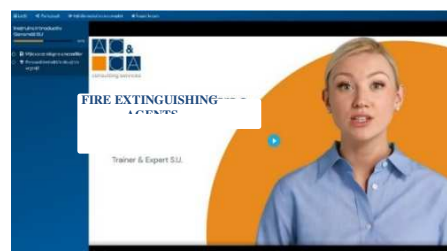


Fig. 5. Digital Training

Fig. 6. Electronic Individual Training Records



Fig. 7. Contractor and Visitor Training

Digital training includes:

Thematic videos and online tests for all training categories: Introductory, On-the-job, Periodic, Additional periodic training (Fig. 5). Electronic individual OHS training records, digitally signed and stored for long-term retention (Fig. 6).

Contractor and visitor training includes self-service kiosk, training validity check, QR code

issuance, collective and individual recordkeeping.

Medical surveillance and critical competencies include import of medical records; expiration alerts; medical check-up scheduling; gap analysis for regulated professions (e.g., electricians, forklift operators, crane operators).

Accident management and incident investigation includes Instant incident logging, Automatic generation of communication forms, Electronic submission to the Labor Inspectorate (ITM), Deadline tracking for investigations and case file archiving, Electronic accident registers with full-text search.

Digital election of workers' representatives: Secret voting on a private blockchain, Digital signing of ballots and meeting minutes

Organizational authorization management: Monitoring the validity of certifications (OHS, Fire Safety, ISCIR), Alerts and automated tasks for renewal.

High-risk zones and control measures: Predefined library with the option to add new entries, Recommendations for safety measures and personal protective equipment (PPE)

3.3 Illustrative Operational Flow

a) *Employee onboarding:* HR creates the contract - data is sent via API; the system checks the medical file and competencies; The application schedules the introductory training, sends a link to video materials and the test; After passing the test, the training form is digitally signed and archived; the employee's compliance status becomes 100%

b) *Job change.* The event is received from HR; the rule engine detects the need for new training and updates the internal decision. A draft decision is automatically generated, the signature workflow is launched; upon validation, acknowledgment notifications are sent

c) *Medical file expiration.* 30 days before expiration, the system notifies the employee, HR department, OHS officer, and occupational health service. Upon renewal, the new file is

uploaded and validated. HR/OHS officer sets the new expiration date in the system.

d) *Workplace incident.* The OHS officer selects the employee, fills in the details/circumstances of the event and its consequences. The communication form to ITM is generated by the application and can be printed or emailed to the relevant authorities depending on the type of accident. Legal investigation deadlines are activated. A checklist is generated with all required steps and recommended completion deadlines to ensure the investigation committee doesn't miss anything. The case file is created digitally, with automatic alerts for legal deadlines

e) *Company authorization renewal* (e.g., ISCIR authorization for a thermal plant). The application signals the upcoming expiration of the thermal plant's authorization 60 days in advance. The technical manager renews the authorization, uploads the new documents, and sets the new validity date. The dashboard returns to a "green" status.

By integrating these functionalities, the platform provides a comprehensive OHS compliance dashboard, reduces administrative burden, and ensures permanent availability of critical documents. The software module covers personnel management, training planning, qualification monitoring, accident reporting, and automatic generation of internal decisions, assisting users with real-time notifications. Testing in three pilot companies revealed 96% reduction in document issuance time and 82% decrease in nonconformities.

Table 2
User Feedback on the Integrated Software Module.

Indicator	Traditional system	Digital system	Variation
Time to issue HSE decision	3 days	1 h 15 min	-96 %
Nonconformities per year	17	3	-82 %
Paper cost (RON)	18 600	1 250	-93 %
Training confirmation rate	78 %	100 %	+22 pp

Key benefits of implementing the integrated software module for occupational health and safety management:

- *Cost Reduction*: Eliminates paper usage, storage space, and administrative time
- *Improved Compliance*: Automatic alerts for expirations, gaps, or nonconformities
- *Accessibility*: Employees can sign, view, and confirm training courses from anywhere
- *Auditability*: Every action is timestamped and assigned to a responsible person

Challenges of implementing the integrated software module for occupational health and safety management: implementation costs, cultural resistance to change.

4. RESULTS

The implementation of an integrated IT system within a commercial company represents a strategic initiative with the potential to significantly improve operational efficiency, product quality, and employee safety. This type of system brings benefits through process automation, real-time monitoring, and advanced data analysis, thus contributing to optimal risk management.

In a world where digitization is redefining all fields of activity, Occupational Health and Safety (OHS) can no longer remain anchored in traditional methods. From paper-based training records to physically signed internal decisions archived in folders, outdated systems no longer meet current requirements for efficiency, traceability, and legal compliance. In 2025, OHS digitization is not just an option, it is a strategic and legal necessity.

One of the most important features of the system is its ability to collect and centralize data in real time. This capability enables continuous monitoring of critical parameters, ensuring a complete and up-to-date view of the current situation. Technologies used include IoT sensors, mobile devices, and digital interfaces, which automatically send data to a central platform. This constant flow of information reduces decision-making latency and provides a solid foundation for further analysis.

Using machine learning algorithms and statistical models, the system can perform predictive analyses based on historical data and current values. This allows the identification of patterns, trends, and warning signals that indicate potential problems or future risks - such as equipment failures, declining employee performance, or exceeding critical thresholds. This predictive approach enables organizations to anticipate negative events and take corrective actions before significant consequences occur.

Based on data analysis, the system can trigger automatic alerts when non-compliant or potentially dangerous conditions arise. These alerts are sent as mobile app notifications, emails, or messages on the work platform, and can be customized according to severity level. Furthermore, the system can initiate automated preventive interventions, such as adjusting parameters, activating maintenance procedures, or notifying relevant departments - thus reducing response times and operational risks.

To provide a holistic view of operations, the system is designed to integrate easily with ERP platforms (Enterprise Resource Planning) and HRM solutions (Human Resource Management). This interconnectivity ensures bidirectional information exchange, allowing the correlation of individual performance data with available resources, efficient task planning, and more accurate reporting at the team or organizational level. Integration also ensures data consistency and reduces redundancies, contributing to improved organizational efficiency and transparency.

User feedback from the three pilot companies highlights the ease of navigation and instant visibility of compliance status, with data centralized in Table 2.

5. CONCLUSIONS

Digitalizing Occupational Health and Safety Management (OHSM) processes brings tangible benefits: time savings, error reduction, and complete traceability. The software module provides a solid foundation for risk management, ensuring legal compliance and preparing the ground for expansion into other areas (environment, fire safety, occupational medicine). The scalability of the architecture

and the adoption of open standards facilitate replication of the solution in organizations of any size. By automating workflows, eliminating paper, and integrating with existing systems, OHSM digitalization delivers measurable benefits: reduced administrative workload, lower costs, faster response times, and improved internal communication. Modern platforms offer real-time visibility into compliance status across all organizational levels.

Compliance with OHSM legislation can no longer be efficiently managed through traditional methods. Digital systems provide traceability, auditability, and the ability to demonstrate compliance at any time, including to authorities. Moreover, they actively contribute to risk prevention, not just documentation. Through digitalization risk assessment becomes a continuous, dynamic, and data-driven process. Automated alerts, gap analysis, and real-time monitoring enable organizations to anticipate issues and intervene proactively, significantly reducing the likelihood of accidents and nonconformities. Digital compliance means more than just following the law it means trust, accountability, and reputation. Organizations that can transparently and thoroughly demonstrate that they protect their employees and comply with regulations earn the trust of partners, clients, and authorities.

A high-performing OHSM platform relies on robust, scalable, and secure technical architecture. Choosing the right technologies, integrating with existing systems, and adhering to the highest security standards are essential for the success of any digitalization project. Qualified electronic signatures are the key to a fully digital transition. They provide legal value to documents, eliminate the need for paper, and enable fast, secure, and legally compliant processes in accordance with European legislation.

Digitalizing OHSM is not just a technology investment, it's an investment in people, safety, and the future. It's an opportunity to transform rigid processes into agile workflows, shift from reaction to prevention, and build an organizational culture based on responsibility, transparency, and innovation. Organizations that

embrace this transformation will not only comply with the law but become more resilient, efficient, and prepared for the challenges of a constantly changing world.

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Digitalizarea proceselor de sănătate și securitate ocupațională: proiectarea și implementarea unui modul software integrat

Acest articol prezintă designul unui modul software integrat dezvoltat pentru digitalizarea proceselor de management al sănătății și securității în muncă (SSM), în conformitate cu cerințele legislative din România. Arhitectura bazată pe microservicii permite integrarea API cu sistemele HR și DMS, în timp ce semnăturile electronice asigură validitatea legală a documentelor. Modulul software acoperă: Managementul personalului, Planificarea instruirii, Monitorizarea calificărilor, Raportarea accidentelor, Generarea automată de decizii interne. De asemenea, oferă asistență utilizatorilor cu notificări în timp real. Testarea în trei companii pilot a relevat: o reducere cu 96% a timpului de emisie a documentelor, o scădere cu 82% a neconformităților. Rezultatele demonstrează că digitalizarea SSM nu este doar o modernizare tehnologică, ci o necesitate operațională care îmbunătățește direct siguranța, eficiența și sustenabilitatea organizațională.

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