perosh
PARTNERSHIP FOR EUROPEAN RESEARCH IN OCCUPATIONAL SAFETY AND HEALTH

Manchester 9, 10 and 11 September 2025

INAIL

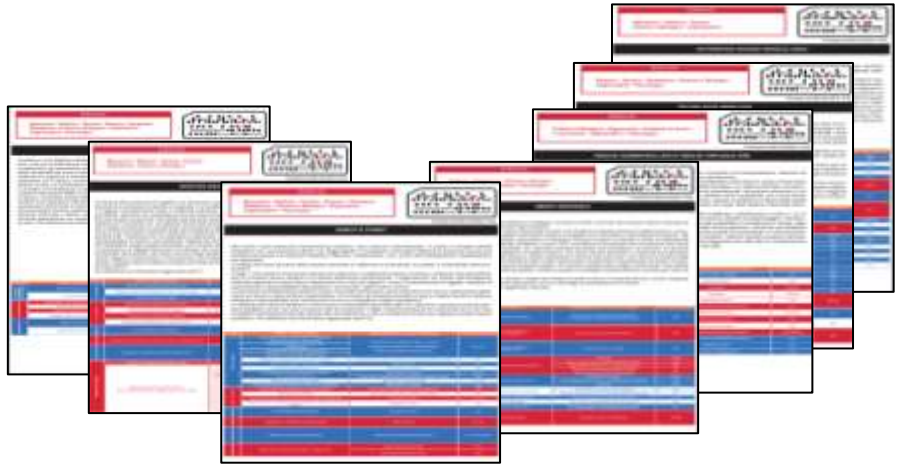
Digital transformation: organisational resilience for managing new emerging OSH risks

Edvige Sorrentino, Sara Stabile, Rosina Bentivenga, Emma Pietrafesa
Department of Occupational and Environmental Medicine, Epidemiology and Hygiene, INAIL, Rome, Italy
Margherita Bernabei
Department of Mechanical and Aerospace Engineering, Sapienza University of Rome, Rome, Italy
Silvia Colabianchi
Department of Engineering and Science, Universitas Mercatorum, Rome, Italy
Francesco Costantino
Department of Computer, Control and Management Engineering Antonio Ruberti, Sapienza University of Rome, Rome, Italy

DIGITALIZATION TRANSFORMING SAFETY AND HEALTH IN THE WORKPLACE

Emerging risks in OSH

Digital technologies present new risks in occupational safety and health, both traditional and non-traditional in nature, requiring organizations to adapt quickly to changes



TECHNOLOGY/RISK FACTORS FACTSHEETS

Article

New and Emerging Hazards for Health and Safety within Digitalized Manufacturing Systems

Francesco Costantino [1,*], Andrea Falegnami [1], Lorenzo Fedele [1], Margherita Bernabei [1], Sara Stabile [2] and Rosina Bentivenga [2]

[1] Department of Mechanical and Aerospace Engineering, Sapienza University of Rome, Via Eudossiana 18, 00184 Rome, Italy; andrea.falegnami@uniroma1.it (A.F.); lorenzo.fedele@uniroma1.it (L.F.); margherita.bernabei@uniroma1.it (M.B.)

[2] Department of Occupational and Environmental Medicine, Epidemiology and Hygiene, INAIL (Istituto Nazionale Assicurazione Infortuni sul Lavoro), Piazzale Giulio Pastore 6, 00144 Rome, Italy; sa.stabile@inail.it (S.S.); r.bentivenga@inail.it (R.B.)

* Correspondence: francesco.costantino@uniroma1.it

Abstract: The Fourth Industrial Revolution is radically reshaping the procedures and the manufacturing environments through the digitalization process. The digitalization process can change according to the context and to specific solutions, and it is able to modify manufacturing systems and production areas. All the employees are directly affected by the transformation of the working environment, manufacturing tools, and working conditions and by the increasing need for new competencies. In this context, it is crucial to identify new and emerging hazards concerning the health and safety of the employees to ensure a conscious and safe digital transformation for everyone involved. In this regard, the paper presents the state of the research and defines seven areas of interest for a safe and harmless digital transformation for the employees, drawing attention to the hazards in the different technological areas. The state of the research unveils the absence of detailed analysis to identify specific hazards of 4.0 technologies. Therefore, every specific 4.0 technologies is analyzed by an extensive review to provide a comprehensive matrix of new and emerging hazards for health and safety within digitalized manufacturing systems. The results can help manufacturing organizations to perform robust risk assessments for worker when introducing specific 4.0 technologies.

check for updates

Citation: Costantino, F.; Falegnami, A.; Fedele, L.; Bernabei, M.; Stabile, S.; Bentivenga, R. New and Emerging Hazards for Health and Safety within Digitalized Manufacturing Systems. *Sustainability* **2021**, *13*, 10948. https://doi.org/10.3390/su131910948

Keywords: health and safety; Industry 4.0; digital transformation; smart factory; workers; risk management

tra-d-a-r-s
Trasformazione Digitale Analisi Rischi Sicurezza

INAIL perosh

RISK OF WORKFORCE DISPACEMENT

- Automation of repetitive tasks
- AI replacing decision- making roles
- Skill obsolescence
- Job polarization
- Psychosocial impacts

INTEGRATION OF ROBOTICS AND AI IN WORK CONTEXTS

Process automation and the use of intelligent systems change the dynamics of responsibility

Liability in the event of error or malfunction

Ethical dimension of algorithmic decision-making

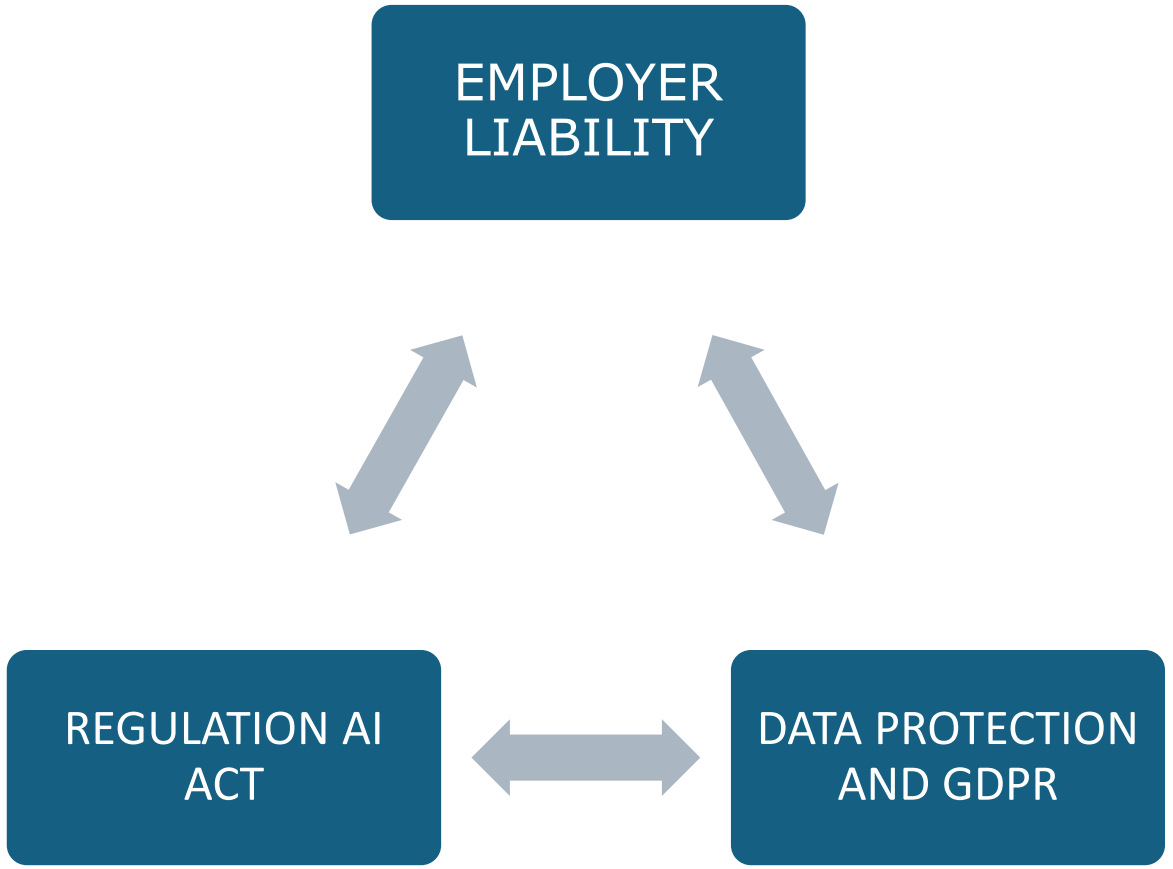
Ensure transparency, fairness and accountability in self-governing decision-making processes, especially when they affect workers' rights

Cybersecurity

Increasing digitalization exposes infrastructures to increasingly sophisticated cyber threats, requiring greater protection of personal data and defense against cyber attacks

LEGAL PROFILES OF NEW RISKS

- The obligation of complete risk assessments in the workplace



- Principle of transparency and comprehensibility (art 22 GDPR)
- Threat to data minimization and security (art.5 e 32 GDPR)

- Obligations for high-risk systems
- Accountability and compliance

Project TRA.D.A.R.S

Collaborative Research funded by Inail BRIC
2019/2021 – ID 50

Risk analysis and mitigation tools for the protection of workers' health and safety in work contexts subject to digital transformation

Department of Occupational and Environmental Medicine, Epidemiology and Hygiene

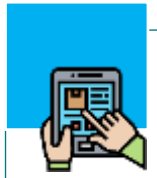
Department of Mechanical and Aerospace Engineering

Department of Law, Economics, Politics and Modern Languages

Department of Philosophy and Educational Sciences

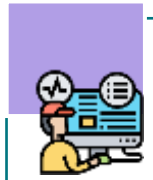
RAG MODEL (RESILIENCE ANALYSIS GRID)

4 SYSTEMIC POTENTIALS



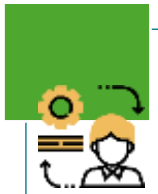
RESPOND
know what to do

changes, disorders and opportunities



MONITOR
know what to be looking for

events, performances and activities with negative and positive impact



LEARN
to know what happened

from experience, especially the right lessons from the right experiences, considering both successes and failures

ANTICIPATE
know what to expect

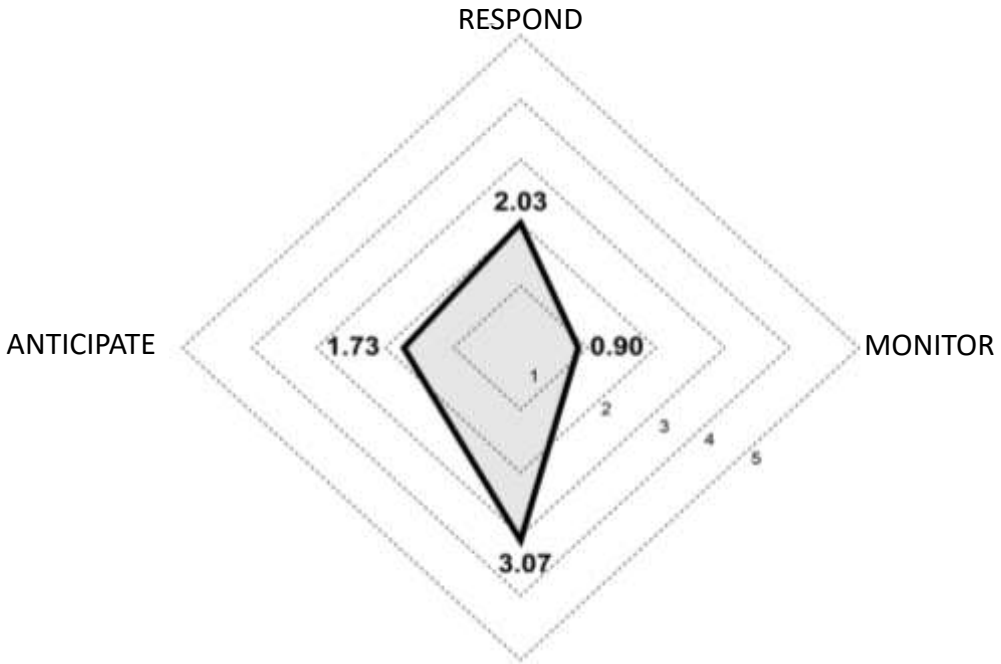
the occurrence of adverse events or not

Hollnagel E., 2017 Epilogue: RAG–the resilience analysis grid. In: Resilience engineering in practice. CRC Press; 2017. 275-296.

DEVELOPMENT AND TESTING OF THE ORGANIZATIONAL RESILIENCE MODEL

Organizational resilience:ability of an organization to anticipate, prepare, respond, adapt to change and unforeseen events with the aim of surviving and improving

ASSESS POTENTIAL STATE OF RESILIENCE



Adriaensen, A., Bernabei, M., Costantino, F., Falegnami, A., Stabile, S., & Patriarca, R. 2023. Resilience Potentials for Health and Safety Management in Cobot Applications Using the Resilience Analysis Grid. ASME Journal of Manufacturing Science and Engineering, 145(10), 1–17.

Declined on collaborative robotics (COBOT)

The assessment model involves the administration of a questionnaire, facilited by a research team group

15 Companies partecipated - located in Northen and Central Italy, Belgium and Netherlands – mainly in the manifacturing sector

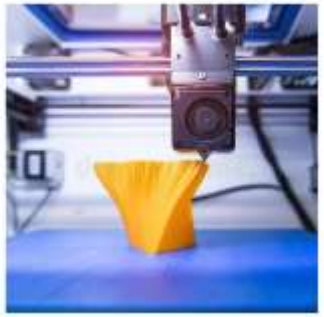
SELF ASSESSMENT


SELF-DRIVING VEHICLES


ROBOT/COBOT


EXOSKELETONS


WEARABLE DEVICES


ADDITIVE MANUFACTURING


VIRTUAL AND AUGMENTED REALITY


WIRELESS TECHNOLOGIES

Questionnaire consists of 3 sections:

1. **self-assessment of the risk for the specific technology**
2. **self-assessment of the risk derived from the interaction of technology with the environment and the work context**
3. **training and re-skilling strategies**

Self Assessment

Companies can fill them out online on project website and receive a free report

https://www.tradars.it/autovalutazione

- ✓ **REPORT ON STATE OF RESILIENCE**
- ✓ **OPERATIONAL INDICATIONS AND SUGGESTIONS FOR THE MANAGEMENT OF RISKS AND TRAINING PROCESSES**

INAIL

perosh
PARTNERSHIP FOR EUROPEAN RESEARCH IN OCCUPATIONAL SAFETY AND HEALTH

Project FEREO

FEREO
FORMAZIONE E RESILIENCE ENGINEERING ORGANIZZATIVA

www.fereo.it

Collaborative Research funded by Inail BRiC
2022– ID 63

Training and Organizational Resilience Engineering with new enabling technologies

ONGOING PROJECT

INAIL
ISTITUTO NAZIONALE PER L'ASSICURAZIONE CONTRO GLI INFORTUNI SUL LAVORO

Department of Occupational and Environmental Medicine, Epidemiology and Hygiene

SAPIENZA
UNIVERSITÀ DI ROMA

Department of Mechanical and Aerospace Engineering

ROMA TRE
UNIVERSITÀ DEGLI STUDI

Department of Industrial, Electronic and Mechanical Engineering

INAIL perosh

Analysis of business processes and organizational models affected by digital transformation

NATIONAL SURVEY OF MANUFACTURING COMPANIES

- ✓ *Strengthening companies' knowledge and awareness of new and emerging risks and new challenges imposed by the pervasiveness of digitalization processes in the production organization*

applied sciences

MDPI

Article

Assessing Resilience Practices in the Digital Transformation Era: A Storytelling-Based Cross-Sectional Study in Italy

Sara Stabile [1], Rosina Bentivenga [1], Emma Pietrafesa [1], Edvige Sorrentino [1], Margherita Bernabei [2], Silvia Colabianchi [3] and Francesco Costantino [4,*]

[1] Department of Occupational and Environmental Medicine, Epidemiology and Hygiene, Istituto Nazionale per l'Assicurazione contro gli Infortuni sul Lavoro (INAIL), 00144 Rome, Italy; sa.stabile@inail.it (S.S.); r.bentivenga@inail.it (R.B.); e.pietrafesa@inail.it (E.P.); e.sorrentino@inail.it (E.S.)
[2] Department of Mechanical and Aerospace Engineering, University of Rome Sapienza, 00184 Rome, Italy; margherita.bernabei@uniroma1.it
[3] Department of Engineering and Science, Universitas Mercatorum, 00186 Rome, Italy; silvia.colabianchi@unimercatorum.it
[4] Department of Computer, Control and Management Engineering, University of Rome Sapienza, 00185 Rome, Italy
* Correspondence: francesco.costantino@uniroma1.it; Tel.: +39-0677274036

Abstract: This study applies Safety II principles within a storytelling- and RAG-based questionnaire to explore how resilience engineering (RE) principles and practices are perceived and implemented in Italy's manufacturing sector. Before completing the questionnaire, accident and near-miss scenarios were presented through narrative stories. The cross-sectional study on 334 companies reveals that Monitor and Respond are prioritized over Anticipate and Learn, with medium-large companies and those adopting technological innovations showing more advanced resilience-oriented OSH management practices. The study emphasizes the importance of company size and technological adoption in shaping safety practices, recommending investment in innovative solutions and fostering a culture that addresses near misses to prevent severe accidents and support continuous improvement.

FOCUS GROUP

Anonymous questionnaire

SECTION 1: Personal data

SECTION 2: Analysis of the size of the RAG through the storytelling of injuries and near misses

SECTION 3: Analysis of processes affected by digital transformation

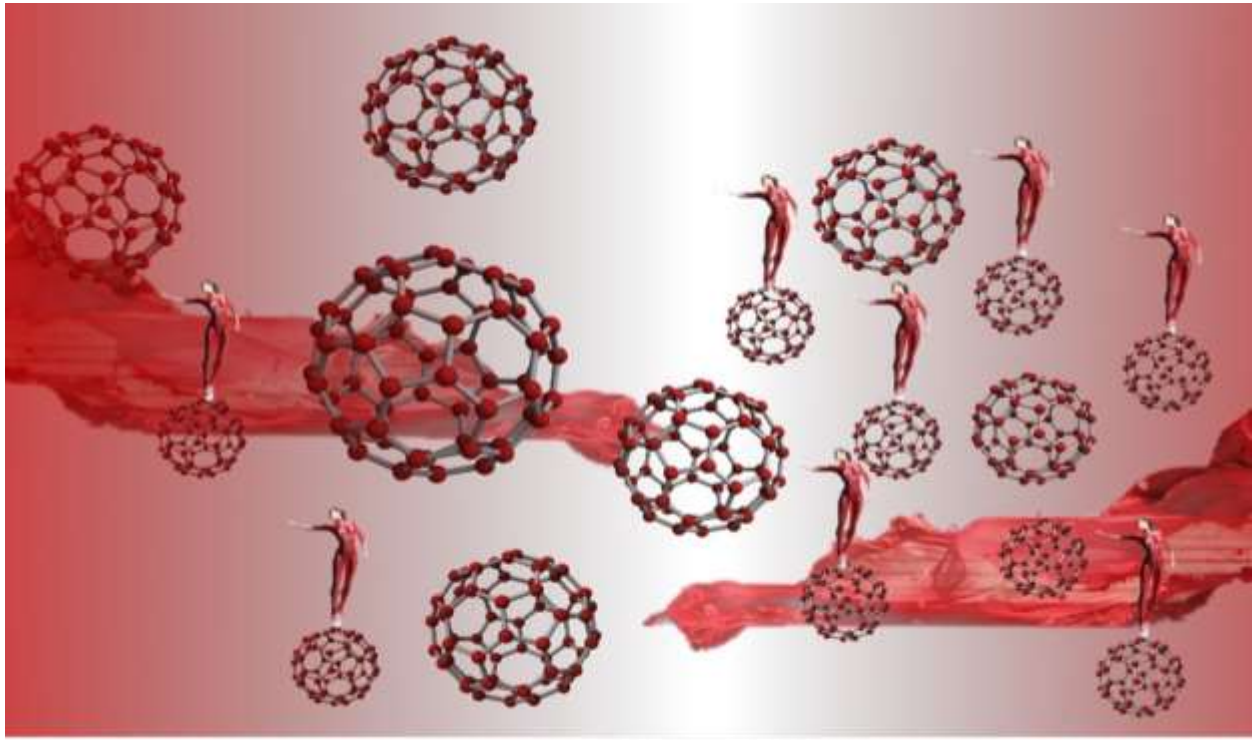
344 respondents

INAIL

perosh
PARTNERSHIP FOR EUROPEAN RESEARCH IN OCCUPATIONAL SAFETY AND HEALTH

THANK YOU FOR YOUR ATTENTION

EDVIGE SORRENTINO
e.sorrentino@inail.it



Collaborations, image by Dee Ashley (Flickr)