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*Ministero dell'Università e della Ricerca*

PRIN: PROGETTI DI RICERCA DI RILEVANTE INTERESSE NAZIONALE – Bando 2022

## **Sustainable Occupational Health and Safety (SOHS) in waste treatment plants: a gamified training tool for workers**

Kick-off meeting

10/11/2023

Department of Education, University of Roma Tre

Via del Castro Pretorio 20, 00185, Rome

Room C04

# PROJECT OVERVIEW

- Settore ERC: SH - Social Sciences and Humanities (SH7\_5 Sustainability sciences, environment and resources)

- Partners:



- Dipartimento di Scienze della Formazione (DSF)



UNIVERSITÀ  
DEGLI STUDI  
DI BRESCIA

- Dipartimento di Ingegneria Civile, Architettura, Territorio, Ambiente e di Matematica (DICATAM)
- Dipartimento di Ingegneria dell'Informazione (DII)
- Dipartimento di Specialità Mediche e Chirurgiche, Scienze Radiologiche e Sanità Pubblica (DSMC)



- Istituto di Scienze e Tecnologie per l'Energia e la Mobilità Sostenibili (STEMS)



UNIVERSITÀ  
DEGLI STUDI  
DI TORINO

- Dipartimento di Scienze della Vita e Biologia dei Sistemi (DBIOS)

- Durata: 24 mesi
- **Avvio progetto: 18/10/2023 - Fine progetto: 18/10/2025**
- Il MUR può autorizzare, previa motivata richiesta, un'estensione temporale della durata del progetto da concludersi comunque non oltre la data del **28 febbraio 2026**.
- **Entro 60 giorni dalla conclusione del progetto**, il PI redige una **relazione scientifica conclusiva** sullo svolgimento delle attività e sui risultati ottenuti.
- La **rendicontazione contabile** è effettuata da ciascun responsabile di unità nel rispetto del "criterio di cassa" e mediante apposita procedura telematica, **entro 60 giorni dalla conclusione del progetto**.

# STATE OF THE ART

## WASTE MANAGEMENT FOR SUSTAINABILITY

- Waste management is crucial to meet the 2030 Agenda's Sustainable Development Goals (SDG) and it largely contributes to the green economy development. In particular, municipal solid waste management (MSWM), which includes materials discarded from residential and commercial sources, accounts for being the largest waste stream and is a major issue facing countries worldwide.
- In this context, recycling/reuse and biological treatments are the dominant processes that convert materials into useful products with economic value and recover energy.
- A growing number of MSW sorting and recovery plants have been established globally, hence more and more people deal professionally with waste handling activities.

## OSH AND RISK EXPOSURE

- Occupational safety and health (OSH) play a significant role in increasing the competitiveness and productivity of firms, but they also have a remarkable impact on enhancing environmental and social issues. However, sustainability is often conceived as related more to environmental and economic concerns, leaving key social and workplace aspects (such as OSH) underemphasized, or completely overlooked.
- The “green” and “safe” binomial becomes particularly challenging for the so-called “Green jobs”, which follow the diffusion and promotion of eco-sustainable productions.
- The increasing complexity of an integrated MSW management systems raises emerging OSH issues for the operators. Combined exposure to multiple risk factors, coupled to a large employment in such sector of foreign people often with a low degree of schooling may be among the main causes of high accident rates. A further main issue is the unpredictability of waste materials that may pose workers sudden and unexpected hazard exposure. Finally, also individual and psychosocial variables may concur to adverse OSH outcomes.
- Much is still unknown about the possible interactions between the abovementioned risk factors and the overall safety and health effect in the MSWM sector.

## ENGAGING TRAINING FOR PREVENTION

- Training workers on risks is a cornerstone of the current Italian legislation on OSH prevention and previous studies in other sectors showed that adequate safety training promotes workers' safe behaviors at individual and group levels, reduces employees' perception of work stress, and increases safety commitment and injury prevention.
- The more engaging training becomes, the greater its effect in terms of knowledge acquisition and reduction of adverse OSH outcomes.
- Unfortunately, highly engaging safety training methods such as hands-on demonstrations are rather costly. More recently, thanks to the introduction of new technologies, training has become more flexible in terms of time management, and it is a cost-effective alternative to practice.
- Digital serious games are a highly engaging training method successfully exploited to train workers in several business fields. Game-based interventions have the advantages of focusing players' attention on specific tasks and allow following a learner-centered approach to education, rather than an approach where the teacher controls the learning.

# AIMS OF THE PROJECT

- 1) To **perform a multidimensional occupational risk assessment** including biomechanical, chemical, biological and psychosocial risk factors during on-plant waste processing and define the corresponding risk scenarios, enriched by individual behavioral components,
- 2) To **design and develop a digital twin** – i.e., a virtual replica of a waste management plant – that allows studying different identified scenarios for workers' training. The scenarios will be replicated as serious games to support the identification of on-site hazards and learn how to perform correct and safe behaviors,
- 3) To **design a prototype of the gamified training solution and test its usability** (in terms of effectiveness, efficiency, and satisfaction) with different groups of workers, representing the extremes of human variability (in terms of age, gender, cultural differences, and level of work expertise).

# MATERIALS AND METHODS

## 7 MAIN PHASES

- Case studies identification:
  - GHIRARDI srl (75 workers)
  - GAIA S.p.a. (15 workers)
  
- Risk assessment (A) Documentary phase:
  - Analysis of secondary and epidemiological data, data on previous training
  - Analysis of company Risk assessment documentation (DVR) according to the Italian Legislative Decree 81/08. →complementary risk assessment if needed
  - Analysis of the technical and operational features of the plants that represent the case studies → Existing documentation (projects, past monitoring campaigns, studies, etc.) and operational data of the plant for the last three years (MFA)



- Risk assessment (B) On field phase:

- Contextual inquiry of the individual risk factors → on-plant observations
  - Tasks breakdown: Hierarchical Task Analysis and Link Analysis
  - Psychosocial and behavioral risk factors and attitudes toward technologies for training: questionnaires and semi-structured interviews

- In-situ assessment of hazards exposure levels:

- Assessment of chemical and microbiological risk
- Assessment of chemical risk deriving from GHG and ammonia emissions from OFMSW composting sites
- Assessment of biomechanical risk → Hazard and caution zone checklist of Washington Checklist, HAL ACGIH, OCRA Checklist, OREGO and the Rapid Upper Limb Assessment (RULA) method.

- Identification of the risk scenarios:

- A “task X workstation X risk” matrix will be designed, weighing risk exposure in each cell on the associated psychosocial factors.
- A score will be attributed to each risk scenario (i.e., each cell of the matrix), in view of the development of the plant digital twin and game mechanics and dynamics. The different risks cutoff values will be used as a criterion to define the reward/penalty score when the operators perform work tasks in the game.
- Correction factors and/or different choices in the game score attribution based on operators’ variability.
- Results from the HTA and LA will be considered in the development of game dynamics (check task pre-requisite)

- Design and development of a prototype of SOHS gamified tool:
  - User research
  - User Experience design
  - Scoring system design
  - Sketches and wireframes
  - Design handoff → software development consulting firm: PHILMARK GROUP, ROMA. Time for prototype development (TRL: 5): 2-3 months
- Evaluation of the prototype usability
  - Usability testing (questionnaires, interviews, observations) with groups of potential end-users representing the variability of the workforce operating in the targeted sector, in terms of age, gender and cultural differences → CAUTO COOPERATIVA SOCIALE (20 operators)
  - Report with suggestions of improvements



## WP2: Context analysis and case studies specification (M1-M5)

**WP leader:** UNIBS– Other WP participants: CNR

**Aim:** analyzing the state of the art on waste treatment and OSH issues and collecting epidemiological and secondary data on OSH issues from the waste management plants under investigation, to identify the expected most critical work tasks and workstations.

### **Tasks:**

**Task 2.1:** Analysis of existing literature on waste treatment plant processes and OSH (CNR)

**Task 2.2:** Analysis of the technical and operational features of the case studies (UNIBS)

**Task 2.3:** Analysis of case studies epidemiological and secondary data on OSH issues (UNIBS)

### **Deliverables:**

**D2.1** Report on literature review (M2)

**D2.2** Report on the technical and operational features of the case studies (M5)

**D2.3** Identification of critical work tasks and workstations in terms of biomechanical, chemical and microbiological risk based on secondary data from the case studies (M5).

## WP3: On-field risk assessment (M5-M10)

**WP leader:** CNR - Other WP participants: RM3, UniBS, UniTO

**Aim:** Measuring on-site specific level of exposure to (chemical, biological and biomechanical) hazards and assessing the individual risk factors (work behaviors, safety-related beliefs, risk perception, attitudes toward PPE adoption, training needs) to identify the actual most critical tasks and workstations.

### Tasks:

**Task 3.1:** In-situ measurements of waste treatment plants airborne pollutants (chemical risk) (CNR)

**Task 3.2:** In-situ measurements of waste treatment plants airborne pollutants (microbiological risk) (UniBS)

**Task 3.3:** Analysis of working postures and movements (biomechanical overload risk) (UniTO)

**Task 3.4:** Analysis of operators' work and OSH-related perceptions and attitudes (psychosocial risks)(RM3)

### Deliverables:

**D3.1** Report summarizing the critical work tasks and workstations in terms of biomechanical, chemical and microbiological risk, workers' behaviors and psychosocial factors, based on observed conditions in the case studies (M10)

## WP4: Risk scenarios definition (M10-M14)

**WP leader:** RM3- Other WP participants: UniBS

**Aim:** Defining the risk scenarios, based on the combination between tasks and workstations with the different levels of chemical, biological and biomechanical risk exposure, weighted on the basis of the psychosocial risks detected. Scoring the different scenarios based on their severity and describing the corresponding training content to be delivered.

### Tasks:

**Task 4.1:** Definition of the risk scenarios matrix (RM3)

**Task 4.2:** Identification of the training content to be delivered (RM3)

**Task 4.3:** Scoring system design (UniBS)

### Deliverables:

D4.1 Risk scenarios matrix and description of the training contents to be communicated for each identified risk scenario (M14)

D4.2 Report on scoring system design for the gamified tool (M14)

## WP5: User profiling, user requirements specification and prototype development (M10-M19)

**WP leader:** RM3- Other WP participants: UniBS

**Aim:** Research on the potential users of the gamified tools and, on the basis of the outcome of the previous WPs, design of the prototype. Development of a prototype, informed by the interaction design phase.

### **Tasks:**

Task 5.1: User research (RM3)

Task 5.2: User Experience design (UNIBS)

Task 5.3: Sketches and wireframes (UNIBS)

Task 5.4: Design handoff (debriefing of UNIBS on the prototype design to inform the development phase)

Task 5.5: Prototype development (RM3) → PHILMARK

### **Deliverables:**

D5.1 Report on the design of the gamified tool (M16)

D5.2 Report on the development of the gamified tool (M19)

## WP6: Prototype usability testing (M20-M23)

**WP leader:** UNIBS - Other WP participants: --

**Aim:** Evaluation of usability and user experience of the prototype of the gamified tool and drafting of suggestions for improvement to be considered in future research and development opportunities.

### **Tasks:**

**Task 6.1:** Evaluation of usability and user experience (UNIBS)

**Task 6.2:** Report drafting (suggestions for improvement) (UNIBS)

### **Deliverables:**

D6.1 Report on usability and user experience evaluation results (M22)

D6.2 Report on suggestions for further improvement of the prototype (M23)



## **WP7: Public engagement, dissemination and exploitation (M1-M24)**

**WP leader:** UniTO - Other WP participants: CNR, RM3, UniBS

**Aim:** to facilitate a rapid, efficient and widespread uptake of SOHS's results, as well as facilitate for the stakeholders' involvement in knowledge production, dissemination and exploitation.

### **Tasks:**

**Task 7.1:** Definition of the communication, dissemination and exploitation strategy (UniTO)

**Task 7.2:** Set up of the SOHS project logo and website (and content updates) (UniBS)

**Task 7.3:** Scientific external dissemination (RM3)

**Task 7.4:** Dissemination among the stakeholders/target groups (CNR)

### **Deliverables:**

**D7.1:** Dissemination, communication and exploitation plan (M3)

**D7.2:** Report on the dissemination, communication and exploitation activities (M24)

## **WP1: Management, coordination and administration (M1-M24)**

**WP leader:** RM3 - Other WP participants: --

**Aim:** guaranteeing the achievement of the project objectives and the individual WPs, meeting the deadlines, project monitoring and reporting, work coordination among all partners, entertain communication with MUR

### **Tasks:**

**Task 1.1:** Administrative, legal and financial management (RM3)

**Task 1.2:** Management of project execution (RM3)

### **Deliverables:**

**D1.1** Project dossier (M24)

**D1.2** Project final technical report (M24)

# METHODS OF DISSEMINATION

- Project logo and website (within the first months)
- Project closing conference (Rome, 2025)
- Scientific publications
- Scientific conferences/exhibition booths
- Networking activity among main stakeholders/target groups:
  - (1) Stakeholders and associations operating in the MSWM, OSH and training sector
  - (2) CReS IELPO (Center for Research and Services for Innovation, Education, Lifelong Learning for People and Organizations and for the Balance of Skills)
- Activities with international research networks:
  - (1) Department of Design Sciences - Lund University, Lund, Sweden/Department of People and Society - Swedish University of Agricultural Science, Alnarp, Sweden
  - (2) IFIP Technical Committee 13 (HCI) Working Group 6 “Human Work Interaction Design” (HWID)
  - (3) Centre for Soil and Applied Biology Segura” (CEBAS)/Consejo Superior de Investigaciones Cientificas” (CSIC)
  - (4) ICOH (International Commission of Occupational Health)