# ONE4ALL - Agile and modular cyber-physical technologies supported by data-driven digital tools to reinforce manufacturing resilience

Project nr: **101091877**

## D4.3 Standardisation activities

**Version: 1.0**

Funded by the European Union

ONE4ALL project is funded by the European Union under the Grant Agreement No 101091877. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or HADEA. Neither the European Union nor the granting authority can be held responsible for them.

| Characteristics of deliverable | |
|---|---|
| Title | ONE4ALL |
| Partner | CRIT |
| Contributors | AUTO, IDE, TUDO |
| Short description of deliverable | Standards identifications and guidelines on how to fulfil them. |
| Submission date | 31/12/23 |
| Type | Report |
| Audience | Public |
| Key words | Standardization, I4.0 Standards |

## ONE4ALL Key Facts

| | |
|---|---|
| **Acronym** | ONE4ALL |
| **Project title** | Agile and modular cyber-physical technologies supported by data-driven digital tools to reinforce manufacturing resilience |
| **GA n°** | 101091877 |
| **Starting date** | 01/01/2023 |
| **Duration-months** | 48 |
| **Call (part) identifier** | CLIMATE NEUTRAL, CIRCULAR AND DIGITISED PRODUCTION 2022 (HORIZON-CL4-2022-TWIN-TRANSITION-01) |
| **Type of Action** | HORIZON-RIA HORIZON Research and Innovation Actions |
| **Topic identifier** | HORIZON-CL4-2021-TWIN-TRANSITION-01-03 |
| **Consortium** | 11 organizations, all EU Member States |
| **Model GA type** | HORIZON Action Grant Budget-Based |

## ONE4ALL Consortium Partners

| N. | Partner | Acronym | Country |
|---|---|---|---|
| 1 | IDENER RESEARCH & DEVELOPMENT AGRUPACION DE INTERES ECONOMICO | IDE | ES |
| 2 | INNOPHARMA RESEARCH LIMITED | INNO | IE |
| 3 | CRIT CENTRO DI RICERCA E INNOVAZIONE TECNOLOGICA SRL | CRIT | IT |
| 4 | EXELISIS IKE | EXE | EL |
| 5 | SYDDANSK UNIVERSITET | SDU | DK |
| 6 | AUTOMATIONWARE S.R.L. | AUTO | IT |
| 7 | MADAMA OLIVA SRL | MAD | IT |
| 8 | HOLOSS - HOLISTIC AND ONTOLOGICALSOLUTIONS FOR SUSTAINABILITY, LDA. | HOLO | PT |
| 9 | TECHNISCHE UNIVERSITAT DORTMUND | TUDO | DE |
| 10 | Orifarm Supply S.R.O. | ORI | DK |
| 11 | Karlsruher Institut Fuer Technologie | KIT | DE |

## Disclaimer

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or HADEA. Neither the European Union nor the granting authority can be held responsible for them.

## Executive Summary

D4.3 - Standardisation activities, outlines the initial standardization activities undertaken in the first year of the One4All project. The primary focus of this task is to assess and monitor existing standards in manufacturing management, with specific attention to standards involving the interaction between collaborative robots (cobots) and human workers, AI in manufacturing environments, and environmental and energy management, as well as quality management.

The initial phase of this activity involved a strategic approach to understand the landscape of Industry 4.0 standards. This was accomplished by first categorizing the I4.0 standards into distinct areas relevant to the project's scope. The identified categories included Interoperability, Security & Software, Data Analytics and AI, Robotics and Automation, and the Internet of Things (IoT). For each of these categories, standards pertinent to the One4All project were identified and evaluated. This process was crucial in determining which standards would be most relevant and beneficial for the project's objectives.

The category of Interoperability was treated with a unique perspective: standards ensuring proper communication between various industrial elements within this category were assumed as foundational and taken for granted. The assumption was that these interoperability standards are well-established and integral to any industrial project, thus not requiring the same level of scrutiny as the other categories. Moreover, considering that the project's target is to reach a Technology Readiness Level of 6, standards specifically related to industrial production were not a focus. This decision was based on the recognition that at TRL 6, the project would be in a demonstration phase in a relevant environment, where detailed industrial production standards might not yet be fully applicable or necessary. This allowed to concentrate on standards that are more pertinent to the current stage of the project's development.

The objective was to create a "Standards Collection," a dynamic knowledge base serving as a set of practical guidelines for technology implementation. This collection is intended to ensure that technological implementations within the project align with the highest industry standards, guaranteeing efficiency, safety, and compliance with current industrial trends and regulations. Overall, this deliverable highlights the progress made in the first year and sets the direction for ongoing and future standardization efforts within the One4All project. The aim is to ensure that the project's outputs are in line with current manufacturing standards and contribute positively to the evolution of these standards in the industry. However, the main efforts and contents will be developed from the 2nd year of activities; hence, 2 updates of this first deliverable will be submitted in M24 and M48.

# Table of contents

# List of acronyms

| | |
|---|---|
| DMP | Data Management Plan |
| DT | Digital Twin |
| TRL | Technology Readiness Level |
| I4.0 | Industry 4.0 |
| WP | Work Package |
| OPC UA | Open Platform Communications Unified Architecture |
| AI | Artificial Intelligence |
| ISO | International Organisation for Standardisation |

# List of figures



# List of tables

# 1. Introduction

## 1.1. Aim and scope of task

As mentioned in the executive summary, this deliverable is the report of activities implemented in the first year of the project, connected with the task of standardisation.

Task 4.3 of One4All project has the aim of assessing and monitoring the already existing standards on manufacturing management, with a specific focus on standards related to safe interaction between cobots and human workers, AI in manufacturing environments, environmental and energy management, quality management. CRIT, with the support of project's technology providers and collaborating with standardization bodies and other EU-funded projects, will set up a Standardization Strategy, drafted in the present and also following deliverables.

**Phase 1 – Identify standards related to ONE4ALL (M1-M12)**

In this initial phase, the focus was placed on mapping the existing landscape of Industry 4.0 industrial standards, with a particular emphasis on those relevant to the One4All technologies. This task involved an extensive review and analysis of current standards, aiming to create a detailed and comprehensive overview of the regulatory and best practice frameworks in place.

The process of identifying these standards involved a selection of those standards that were most pertinent and could serve as effective guidelines during this initial phase of technology implementation. This selection process was tailored to address key areas that are fundamental to the successful implementation of project's technologies. These areas included standards related to human safety, ensuring that the interaction between humans and robots is managed safely and efficiently. It also encompassed standards pertinent to software implementation, which are critical in developing reliable and robust technological solutions. Furthermore, the selection focused on standards connected to robotics and machinery.

Given the increasing integration of robotics in I4.0, understanding and adhering to these standards is crucial for ensuring the seamless and safe incorporation of these technologies into existing industrial processes. The overarching aim of this thorough mapping and selection process was to generate a "Standards Collection." This collection is intended to serve as dynamic knowledge base and a set of practical guidelines, offering clear directives and insights that are crucial for the technology implementation phase of the One4All project. By having this collection at disposal, we aim to ensure that every technological implementation within the scope of the project is in alignment with the highest industry standards, thereby guaranteeing efficiency, safety, and compliance with the latest industrial trends and regulations. Figure 1 illustrates the key activities of this phase.


*Figure 1: First phase approach*

One4All partners contributed actively to this phase and the result of the collection of feedback ended with the identification of a set of relevant standards for the project (see Chapter 2). This set will be used for the planning and implementation of the following phases.

As described in One4All Grant Agreement, the expected results of task 4.3 are:

1) Identification of standards related to ONE4ALL;

2) Fulfilment of standards;

3) Contributing to the existing standards;

4) Development of a standardization roadmap.

Whereas the first result has been reached and presented in this deliverable, the others will be analysed in future deliverables.

## 1.2. Relation with other tasks

This first standards' assessment has revealed insights that influence the implementation of technologies and the development of prototypes. This assessment has led to the identification of several project tasks directly related to these findings.

Beginning with WP1 - Human and sustainability impact assessment, the focus is on the multifaceted aspects of human-robot collaboration. This task primarily concerns worker safety and well-being, necessitating the establishment of safety protocols that are in line with international standards. This is vital for ensuring a safe and productive environment where humans and robots can work together effectively.

In WP2 - Data-Driven Digital Twins (DTs), there is a synergistic relationship between this task and the Digital Twin. The Digital Twin, a crucial component of modern industrial systems, relies heavily on standardization for its simulations and predictions to be accurate and reliable. These simulations must reflect the actual constraints and protocols of the industrial sector to be effective. In return, the insights gleaned from the Digital Twin can be instrumental in refining and updating standardization efforts. This ensures that the standards stay relevant and effective, adapting to the rapidly evolving landscape of technology and industrial practices. Together, these endeavors contribute significantly to the development of industrial collaborative robots (cobots) that are robust, efficient, and adhere to compliance standards.

WP3 - Intelligent Orchestration Platform, emphasizes the development of the Intelligent Orchestration Platform of the RCPM's control software. This aspect is especially relevant to the standardization efforts, as it allows for practical testing and refinement of standards in real-world scenarios.

WP4 - Innovative Reconfigurable Cyber-Physical Production Module, is significant for its focus on selecting appropriate hardware for the prototype. This selection process is guided by the standards identified in earlier phases of the project, ensuring that the prototype aligns with established norms and practices.

WP5 - Demonstration Activities and Evaluation, involves applying the standards identified in previous work packages to the tools developed and utilized in demonstrators. This work package is critical as it involves the actual implementation and testing of prototypes, allowing project partners to evaluate the effectiveness of the developed technologies. This phase may also prompt discussions about the

need for new standards, based on the practical experiences and findings during these demonstration activities.

Lastly, Task 7.2 - Technical and Data Management, functions as a repository for documenting potential future developments in standards. This task is pivotal in providing a comprehensive record of how standards evolve in the realms of technical and data management. This documentation is essential for keeping track of changes and ensuring that future developments are grounded in historical context and practical experience.

## 1.3. Industry 4.0 standards and categories

Industry 4.0 (I4.0), the fourth industrial revolution, marks a significant transformation in manufacturing and production industries, driven by advanced digital technologies. This era is characterized by a fusion of technologies blurring the lines between the physical and digital spheres. The foundational aspect of I4.0 is the set of standards that facilitate this integration, ensuring interoperability, security, efficiency, and innovation.

Interoperability standards, such as OPC UA (Open Platform Communications Unified Architecture), play a critical role in I4.0 by enabling diverse industrial systems and devices to communicate and exchange data seamlessly. This connectivity is vital for creating a cohesive and flexible manufacturing environment where various components, regardless of their make or model, can work together harmonically. Another pivotal category is cybersecurity, highlighted by standards like ISO/IEC 27001. As industries become increasingly interconnected, the potential for cyber threats escalates. These standards establish guidelines for implementing robust information security management systems, safeguarding sensitive data and industrial control systems from cyber threats, and ensuring the resilience and continuity of industrial operations.

The integration of data analytics and artificial intelligence (AI) in industrial processes is governed by evolving standards. These standards aim to ensure that AI and machine learning algorithms are used ethically and effectively, enhancing decision-making processes and optimizing production workflows. They address issues such as data quality, algorithmic transparency, and ethical considerations, ensuring that the implementation of AI in I4.0 is both responsible and beneficial. Robotics and automation standards, including ISO/TS 15066 and ISO 10218, are central to the I4.0 framework. They provide guidelines for the safe and efficient integration of robotics into manufacturing processes, addressing aspects like collaborative robot operations, human-robot interaction safety, and the reliability of automated systems. These standards are crucial for leveraging the benefits of robotics in manufacturing while ensuring the safety of human workers.

The Internet of Things (IoT) is another key component of I4.0, and it relies on standards such as IEEE 802.15.4 for device connectivity. IoT standards facilitate the integration of a wide range of sensors and smart devices into the industrial ecosystem, enabling real-time data collection and analysis. This connectivity is essential for predictive maintenance, process optimization, and overall operational efficiency. Industry 4.0 also encompasses standards related to digital twin technology, additive manufacturing, and cloud computing, further expanding the capabilities of industries to innovate and adapt to new market demands. As I4.0 continues to evolve, these standards are not static; they are continuously updated to reflect new technological advancements and emerging challenges in the industry. The standards of Industry 4.0 are pivotal in shaping the future of manufacturing and production. They ensure that the transition to a more digital, interconnected, and automated industrial landscape is seamless, secure, and sustainable. By adhering to these standards, industries are not only enhancing their operational efficiency and productivity but are also paving the way for future innovations that will continue to revolutionize manufacturing in the years to come.

In the scope of the One4All project, standardization serves as a linchpin in the development of cobots, machine vision systems, and associated software, bridging the gap between technological deployment and the imperative for safe, efficient, and interoperable operations. This adherence to standardized protocols not only fortifies safety and reliability but also catalyzes innovation and compatibility. Thus, standardization is a critical factor in enabling industries to exploit the full potential of these technologies, leading to augmented productivity, enhanced quality control, and increased manufacturing versatility.

# 2. Relevant standards for ONE4ALL

As the first of four deliverables dedicated to the standardization topic in the One4all project, our primary focus lies in identifying and collating pertinent standards within the realms of Industry 4.0. These standards, pivotal to the development and implementation of the project's technologies, can be categorized into Interoperability, Security & Software, Data Analytics and AI, Robotics and Automation, and the Internet of Things (IoT). Given the project's trajectory towards achieving a Technology Readiness Level (TRL) of 6, it is essential to note that standards specifically tied to industrial production are not within our current scope of consideration.

In this phase, we are laying the groundwork by identifying standards that will guide the development of the Reconfigurable Cyber-physical Production Module (RCPM), the software responsible for the connection to the enterprise control system, and the integrated vision system. While standards under the Interoperability category are deemed established and will be treated as a given baseline, our interest predominantly lies in those under the other categories. This focus is strategic, as it aligns with the project's innovative edge, targeting areas where there is a greater need for guidance and structured development protocols.

Security & Software standards are crucial, considering the need to safeguard operational integrity and protect against cyber threats in an increasingly interconnected environment. In the realm of Data Analytics and AI, standards will ensure the ethical and effective implementation of these technologies, crucial for intelligent data processing and decision-making. Robotics and Automation standards are essential for the safe and efficient integration of robotic systems, a core aspect of our project. Lastly, standards related to IoT will play a significant role in ensuring seamless connectivity and communication between various devices and components within the project's ecosystem. Overall, these standards will not only provide a structured path for development but also ensure compliance, safety, and efficacy in the implementation of the One4All project's technologies.

A significant emphasis is being placed on standards related to the safety interaction between humans and robots. This focus is crucial, as it directly impacts the effectiveness and safety of collaborative work environments. Ensuring secure and harmonious human-robot interaction is not just a matter of technical compliance, but a fundamental aspect of creating a sustainable and efficient operational workflow. These safety standards will be integrated into our project design and execution.

*Table 1: Identified relevant standards*

| CATEGORY | STANDARD | DESCRIPTION |
|---|---|---|
| Robotics and Automation | ISO/TS 15066 | Technical specification for safety in human-robot collaboration, detailing guidelines on speed and separation monitoring, hand-guided operation, and power and force limiting for collaborative robots (cobots) in shared workspaces. |
| | ISO 10218-1 | International standard specifying safety requirements for the design and construction of industrial robots, addressing hazards, risk assessment, and safety functions. |
| | ISO 10218-2 | International standard focusing on safety requirements for industrial robot systems and integration, covering aspects such as installation, safeguarding, and collaborative operation. |
| | IEC 61508 | International standard for the functional safety of electrical/electronic/programmable electronic safety- |

| | | |
|---|---|---|
| | | related systems, encompassing lifecycle requirements from design to decommissioning. |
| | ISO 13849-1 | International standard providing safety requirements and guidance for the design and integration of safety-related parts of control systems, including performance level (PL) calculations. |
| | ISO 13855 | International standard establishing the positioning of safeguards relative to the approach speeds of human body parts, for safety distances in machinery. |
| | EC machinery directive 2006-42 | EU regulation for the safety of machinery design and manufacture. It sets essential health and safety requirements to ensure machinery safety in the EU market. Compliance is mandatory for manufacturers. |
| Security & Software | ISO/IEC 27001 | International standard specifying requirements for an information security management system (ISMS), focusing on the establishment, implementation, maintenance, and continual improvement of information security. |
| | IEC 62443 Series | A collection of international standards providing a framework for industrial network and system security, addressing risk assessment, system design, implementation, and maintenance to secure industrial automation and control systems. |
| | ISO/IEC 15408 (Common Criteria) | International standard offering a framework for the evaluation of security properties of IT products and systems, including criteria for assessing security functionality and assurance in information technology. |
| | IEC 61511 | International standard specifying safety requirements and guidelines for the design, implementation, operation, and maintenance of Safety Instrumented Systems (SIS) in the process industries. |
| | ISO/IEC 29119 | Provides a comprehensive framework for software testing.This standard is aimed at ensuring the quality, reliability, and effectiveness of software through systematic testing practices. |
| | ISO/IEC 12207 | Provides a framework for software life cycle processes. It outlines the tasks and activities involved in initiating, developing, maintaining, and eventually retiring software systems. The standard is designed to ensure the quality and efficiency of software development and maintenance processes. |
| | IEEE 828 | Specifies the requirements for software configuration management plans. It covers the processes and activities necessary to manage software changes effectively, ensuring that all aspects of software development, including design, testing, and maintenance, are systematically controlled and documented. |
| Data Analytics and AI | ISO/IEC JTC 1/SC 42 | Subcommittee that develops international standards for artificial intelligence and machine learning, focusing on their ethical and effective application. |
| | IEEE P7000 Series | Provides guidelines for addressing ethical concerns during the design and development of autonomous and |

| | | |
|---|---|---|
| | | intelligent systems, focusing on transparency, accountability, and user data privacy. |
| | ISO/IEC 25012 | Defines a data quality model, specifying data quality attributes for data retained in a structured format within information systems. |
| | Ethics Guidelines for Trustworthy AI by the European Commission | While not a standard in the traditional sense, these guidelines offer a framework for achieving trustworthy AI, focusing on ethical principles and technical robustness. |
| IoT | ISO/IEC 30141 | Provides a reference architecture for the Internet of Things. It outlines a framework and guidelines for IoT architectures, including essential concepts, terminologies, and architectural components. |
| | ISO/IEC 29100 | A framework for privacy protection in the context of IoT, focusing on personal data protection in information and communication technology systems. |

# Conclusion

The identification and analysis of standards across key categories - Interoperability, Security & Software, Data Analytics and AI, Robotics and Automation, and the Internet of Things (IoT) - have provided a comprehensive understanding of the regulatory and technological landscape. This understanding is instrumental in guiding the project's development, ensuring that it not only adheres to best practices but also leverages the latest advancements in these areas. The project's stance on Interoperability, considering it as a given due to its fundamental role in industrial processes, reflects a strategic focus on areas that require more intensive exploration and development. This decision underscores the project's commitment to efficiency and effectiveness, concentrating efforts where they are most needed.

Additionally, the decision to not prioritize standards related to industrial production, in line with the project's expected TRL 6, focuses the efforts on the R&D side of I4.0. It acknowledges the project's stage of development, focusing on standards that are immediately relevant and beneficial to the project's objectives at this phase. As the One4All project moves forward, the groundwork laid in this initial phase will serve as a valuable compass. It will guide the project through the complex landscape of I4.0, ensuring that each step taken is in line with the highest standards of innovation, safety, and efficiency. The insights gained from this phase will be instrumental in navigating future challenges and opportunities, ultimately contributing to the project's success and its impact on the field of industrial technologies.

## References and Resources

IEEE Xplore Digital Library: A digital library providing access to IEEE journals, transactions, letters, and magazines, as well as conference proceedings and standards. Available at: https://ieeexplore.ieee.org/

International Organization for Standardization (ISO): An independent, non-governmental international organization that develops and publishes a wide range of proprietary, industrial, and commercial standards. Website: https://www.iso.org/

International Electrotechnical Commission (IEC): An international standards organization that prepares and publishes international standards for all electrical, electronic, and related technologies. Find more at: https://www.iec.ch/