AI·PROFICIENT

Artificial intelligence
for improved production efficiency,
quality and maintenance

Deliverable 7.5

D7.5: Standardization activities of AI-PROFICIENT

WP 7: Dissemination, exploitation and standardization

T7.6: Standardization activities alignment and support

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Executive Summary

The Deliverable D7.5 Standardization is a public document of the AI-PROFICIENT project delivered in the context of WP7, Task 7.6: (Standardization activities alignment and support), with regard to the work performed as part of the project to implement standardization related activities.

We present the work performed with respect to Standardization. We analyzed the standards landscape and identified appropriate target standards. We worked with HSBooster to understand standardization and how we could approach it. We identify groups of standards associated with the technologies researched as part of the project which we then associate with project exploitable results. We have a basis to further pursue standardization activities in future projects.

1 Introduction

This document is presenting the potential of AI-PROFICIENT to contribute to standards in the areas that we performed research in and the efforts we made as part of the project to contribute to standards.

We have looked at contributing to standards in multiple directions: Artificial Intelligence, Safety and AI, Industrial Maintenance, Internet of Things support for interoperability, Semantic Ontologies and Ethics.

We also present an overview of the related standards landscape and present what we consider are possible avenues for follow up work.

2 AI-PROFICIENT results with potential for standardization and the standards landscape

Any targeting of potential standards where the AI-PROFICIENT project may contribute starts from:

- Particular technologies researched or used in the project, that the consortium felt were most promising as to their character for contributing to standards.
- The project key exploitable results (KERs) knowing that these KERs are those **expected at the beginning of the project** (to keep a general frame for standardization investigation all along the project). The real KERs provided as project outputs and described in D7.8 are only a subset of the expected ones and therefore are referred to only a subset of standardization activities.

Based on the standards studied and the technologies being developed in the project that we identified as suitable starting points for standardization, we have grouped the standards in five groups which are expanded in Table 1 below.

We then associated the standards groups (Categories of Standards) with the expected KERs of AI-PROFICIENT. The association is shown in the Applicable Categories of Standards column in Table 2.

Table 1: Technologies used in AI-PROFICIENT that were considered as most promising for standardization

	Technology Name (Category of Standard)	**Description**	**Use in AI-PROFICIENT Project**	**Related Formal Standards**
1	Semantics (**SEM**)	Semantic modelling for the data being used in the project	A subset of the **Semantic Sensor** Network Ontology (SOSA) was used to model the sensors and data in a process industry setting and specialized to the AI-PROFICIENT use cases	Semantic Sensor Network Ontology W3C Recommendation
2	Predictive and proactive maintenance and process improvement (**MAINT**)	The primary technical scope of the project addressing the needs of the process industry for maintaining its plant	The specific solutions developed as part of the project use cases focus on these **technical objectives**	CEN EN 17485:2021 - Maintenance within Physical Asset addresses enhancing the value of physical assets throughout their entire life cycle,

		equipment in an optimal manner		ISO 13374 - Condition Monitoring and Diagnostics of Machines focuses on maintenance systems, ISO 55000 Series - Asset Management focuses on lifecycle management of physical asset, IEC 60300 Series - Dependability Management addresses among other matters reliability, maintainability and availability and SAE JA1011- Evaluation Criteria for RCM Processes addresses proactive maintenance strategies
3	Artificial Intelligence (**AI**)	The primary group of technologies researched in the project	The **tools** (technologies, algorithms) used to achieve the technical objectives of the project	The major groups of standards are developed by ISO/IEC JTC 1/SC 42, CEN-CENELEC JTC 21, OMG AIPTF: Artificial Intelligence Platform Task Force and ETSI (especially the SAI series of standards)
4	Interoperability and Internet of Things (**IoT**)	The necessary technologies for extracting, storing and making available the needed input for the AI models	Support for IoT was part of the project development in WP2. Interoperability between industrial data sources and representations and AI data representations was quite important in WP5.	A multitude of standards addresses these technologies. Of particular relevance to AI-PROFICIENT were the MQTT 3.1.1 and 5.0 standards.
5	Ethics in AI (**ETHICS**)	Ensuring that the application of AI in the project and its outcome is ethical	A horizontal activity spanning all project activity as Ethics by Design.	A major group of standards is by the IEEE IEEE P7000 Working Group and in particular the standards IEEE **7000-2021** - IEEE Standard Model Process for Addressing Ethical

				Concerns during System Design, **7001-2021** - IEEE Standard for Transparency of Autonomous Systems and **7007-2021** - IEEE Ontological Standard for Ethically Driven Robotics and Automation Systems [ISO/IEC AWI TS 22443](#) - Guidance on addressing societal concerns and ethical considerations is a standard under preparation.

Table 2: Overview of AI-PROFICIENT expected KERs and their links with categories of standards

	Outcome Name	**Description**	**Applicable Categories of Standards**
1	Surrogate Data Driven Explainable Model	Focuses on semantic models and XAI methodologies for manufacturing and chemical industries.	AI, ETHICS
2	Smart Data Handling with Semantic Models in Industry	Aims to improve explainability and trustworthiness in data handling.	SEM, IoT, AI, ETHICS
3	Post-Hock Anomaly Analysis Explainable AI	Involves the development of AI models for anomaly analysis.	AI, MAINT, ETHICS
4	Connected Worker Additive Check Application Using Innovative Human-Machine Interfaces	Focuses on enhancing quality control feedback and additive selection in industrial processes.	AI, MAINT, ETHICS
5	Data Quality Analysis Module	GO-QData - A software module for evaluating data quality in various industries.	AI, ETHICS
6	Machine Vision for Dimensional Measurement and	Pertains to industrial inspection and the use of limited data sets.	MAINT, ETHICS

	Positioning with Small "Bad" Datasets		
7	Detection of Fault or Wear Location	Involves the identification of faults or wear in machinery.	AI, MAINT, ETHICS
8	Data-Driven Predictive AI Analytics for Prognostics Based on DL	A KER focusing on predictive analytics in industrial domains.	MAINT, ETHICS
9	Data-Driven AI Analytics for Maintenance Strategy Optimization	Aims to optimize maintenance strategies using AI analytics.	AI, MAINT, ETHICS
10	Natural Human-Computer Interaction	Develops more natural and efficient interaction systems between humans and machines.	ETHICS
11	Process Anomaly Detection Module	GO-QNormality: A software module dedicated to the detection of anomalies in industrial processes.	AI, MAINT, ETHICS
12	Multi-Objective Optimizer Generative and MI(N)LP Optimization Solvers	Focuses on multi-objective optimization in various industries.	MAINT, ETHICS
13	Process Models and Digital Twins	Involves the development of process models and digital twins for industrial applications.	MAINT, ETHICS
14	Semantic Accountability Tool	A tool designed to support accountability in AI models, focusing on algorithm data and design processes.	SEM, AI, ETHICS

2.1 Semantics

In order to be able to make use of large collections of measurements and support data analysis and design of modelling experiments, the meaning (semantics) of each piece of available data must be understandable to the analysts, programmers and end users of the models. Furthermore, in order to be able to understand what the logical relationships between these data entities are, we also need a system of type and relationship definitions that constitute and ontology. Combining them into a semantic ontology we are able to use this contextual information to understand what the physical meaning of a quantity is (as compared to looking at it as a pure mathematical variable). Starting with a more general semantic ontology standard, we want to consider a specialized subset for the process industry, potentially with industry and process class specific extensions and adaptations.

2.1.1 Semantic Sensor Network (SSN) Ontology Description

The Semantic Sensor Network (SSN) Ontology (Semantic Sensor Network Ontology W3C Recommendation), endorsed as a W3C Recommendation, is a framework for describing sensors, their observations, and associated processes. It encompasses the description of sensors, the observational procedures they employ, the features of interest being studied, the samples used for these studies, and the properties observed. Additionally, it covers actuators involved in these processes.

A key feature of the SSN ontology is its modular architecture, comprising a core ontology named SOSA (Sensor, Observation, Sample, and Actuator). This core ontology provides elementary classes and properties and is both lightweight and self-contained. The design of SSN and SOSA allows for varied degrees of axiomatization and scope, making these ontologies adaptable to a broad spectrum of applications and use cases. These use cases include, but are not limited to, satellite imagery, large-scale scientific monitoring, infrastructure monitoring (both industrial and domestic), social sensing, citizen science, observation-driven ontology engineering, and applications in the Web of Things.

The comprehensive nature of the SSN ontology, along with the SOSA core, facilitates the integration and interoperability of sensor data across different systems and domains. This enables a more cohesive and efficient approach to handling sensor data, which is essential in the era of big data and the Internet of Things (IoT)

2.1.2 Method of contribution

There is a current W3C editor's draft of the proposed update of the standard available in [Semantic Sensor Network Ontology (w3c.github.io)].

Contributing to the Semantic Sensor Network (SSN) Ontology, a W3C Recommendation, is possible via:

1. The GitHub Repository: The primary platform for contributing to the SSN Ontology is through the above GitHub repository. Contributors can submit comments, propose changes, or discuss issues related to the ontology.
2. The Mailing List Archive: In addition to GitHub, there is an archive of the mailing list for the Spatial Data on the Web Working Group, which published the SSN Ontology. This archive can provide additional context and historical discussions around the ontology.
3. The W3C Working Group: Engaging directly with the relevant W3C Working Group, i.e., the [Spatial Data on the Web Working Group].

We have used a subset of the SOSA standard in AI-PROFICIENT. Restricting the SOSA standard can be a process industry specific standards application guideline document, that in itself can be formalized. Contribution to W3C standards can be easier as the process is more open than say the ISO process.

2.2 Predictive and proactive maintenance

In AI-PROFICIENT we are concerned specifically with predictive and proactive maintenance. We identify the core standards describing maintenance systems and processes. The challenge for AI application is finding the correct way to incorporate AI in these processes and systems so that all stakeholders in the maintenance process (owners, maintainers, internal auditors, plant managers, classification societies and inspectors, insurers and regulators) have confidence in the use of AI for maintenance and accept the ensuing processes as a standard, acceptable way of operating. To this end we identify five standards (or standards series) that would benefit in their next updates from explicit support for AI derived models for predictive (on condition) maintenance and proactive (root cause determination driven) maintenance.

2.2.1 CEN EN 17485:2021 Maintenance within Physical Asset Management

CEN EN 17485:2021 **-** Maintenance within Physical Asset Management**,** is a comprehensive European standard that outlines a framework for enhancing the value of physical assets throughout their entire life cycle. This document, published in June 2021 by the European Committee for Standardization (CEN) and managed by CEN/TC 319 Maintenance, is primarily focused on integrating maintenance as a crucial aspect of physical asset management. It specifies various methods and procedures for applying physical asset management effectively, emphasizing the importance of maintenance as a significant influencing factor in both strategic and tactical decision-making regarding an organization's physical assets**.**

The standard provides guidelines for using physical asset management as a framework for maintenance activities, ensuring that maintenance considerations are appropriately incorporated into broader asset management strategies. **Contribution is via the CEN process for standards and** CEN/TC 319 Maintenance**.**

2.2.2 ISO 13374 - Condition Monitoring and Diagnostics of Machines

ISO 13374 - Condition Monitoring and Diagnostics of Machines, specifically ISO 13374-4:2015, is a standard that focuses on the requirements for presenting information for technical analysis and decision support within condition monitoring and diagnostics (CM&D) systems. This standard is crucial for software design professionals who need to present diagnostic and prognostic data, health information, advisories, and recommendations to end-users. Contribution is via the ISO process for standards development.

2.2.3 ISO 55000 Series - Asset Management

ISO 55000 Series - Asset Management focuses on lifecycle management of physical assets. The ISO 55000 series, encompassing ISO 55000, ISO 55001, and ISO 55002, provides a comprehensive framework and guidelines for the formulation and implementation of an effective and integrated asset management system. These standards address the management of both tangible and intangible assets, aiming to create a universal standard in asset management systems.

At the heart of asset management, according to these standards, is the maximization of value derived from assets. This involves optimizing processes related to the planning, selection, acquisition, development, *utilization*, *maintenance*, and renewal or disposal of assets within an organization. The series emphasizes the importance of aligning asset management practices with organizational objectives to achieve *optimum value for money* and meet stakeholder expectations.

Contribution is via the ISO process for standards development.

2.2.4 IEC 60300 Series - Dependability Management

IEC 60300 Series - Dependability Management addresses among other matters reliability, maintainability and availability. The IEC 60300 series, particularly IEC 60300-1:2014, establishes a comprehensive framework for dependability management. It is designed to provide guidance on managing the dependability of products, systems, processes, or services, incorporating hardware, *software*, and human aspects, or any integrated combination of these elements.

Contribution is via the IEC process for standards development and the standard is developed by IEC TC 56. The IEC National Committee of France is *AFNOR - Comité Electrotechnique Français*.

2.2.5 SAE JA1011 - Evaluation Criteria for RCM Processes

SAE JA1011 - Evaluation Criteria for RCM Processes addresses proactive maintenance strategies. Section 2.2.4 of the SAE JA1011 standard, outlines specific criteria for processes to be considered compliant with Reliability-Centered Maintenance (RCM). This document provides the foundational requirements for any process to be classified as RCM. The standard was last revised in 2009 and is developed by the G-11M, Maintainability, Supportability and Logistics Committee within SAE International.

2.3 Artificial intelligence

The number of standards being developed to support the field of Artificial Intelligence has been keeping pace with the equally frenetic development rate of AI technology itself. There are four primary groups of standards (ISO/IEC SC42, CEN-CENELEC JTC 21, OMG AI PTF and ETSI OCG AI) being developed at the international level by the following organizational groups.

2.3.1 ISO/IEC JTC 1/SC 42

ISO/IEC JTC 1/SC 42 is a subcommittee of the Joint Technical Committee ISO/IEC JTC 1 of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) and focuses on the standardization within the field of Artificial Intelligence. Contribution is via the ISO process. Contribution is via the ISO process. Standards that are applicable in the domains explored by AI-PROFICIENT include the following aspects.

2.3.1.1 Published Standards

1. ISO/IEC TS 4213:2022 - Assessment of machine learning classification performance
2. ISO/IEC TR 24028:2020 - Overview of trustworthiness in artificial intelligence
3. ISO/IEC TR 24368:2022 - Overview of ethical and societal concerns

2.3.1.2 Standards under Development

1. ISO/IEC DIS 5259 - Data quality for analytics and machine learning (ML)
2. ISO/IEC DTR 5469 - Functional safety and AI systems
3. ISO/IEC CD TS 6254 - Objectives and approaches for explainability and interpretability of ML models and AI systems
4. ISO/IEC CD TS 8200 - Controllability of automated artificial intelligence systems
5. ISO/IEC CD 12792 - Transparency taxonomy of AI systems
6. ISO/IEC AWI TS 17847 - Verification and validation analysis of AI systems
7. ISO/IEC AWI TS 22440 - Functional safety and AI systems Requirements
8. ISO/IEC AWI TS 22443 - Guidance on addressing societal concerns and ethical considerations.

   The large number of related ISO standards currently under development and in early stage, makes these standards primary targets for contribution. The difficulty lies in the indirect ISO process where contribution has to be made on a per country basis, at the level of country shadow TC.

2.3.2 CEN-CENELEC JTC 21

CEN-CENELEC JTC 21 - 'Artificial Intelligence,' is a Joint Technical Committee established by CEN (European Committee for Standardization) and CENELEC (European Committee for Electrotechnical Standardization). It is responsible for the development and adoption of standards for AI and related data and focuses on producing standardization deliverables that address European market and societal needs while aligning with EU legislation, policies, principles, and values. The Secretariat of JTC 21 is held by DS, the Danish Standardization Body. The committee's activities support harmonized standards in support of the upcoming AI Act.

The importance if these standards lies in the fact that they will be the basis of EU law. Upon publication and implementation by the EU member states, these standards become legally binding. As CEN-CENELEC commonly incorporates ISO or country level standards into the European standards, direct contribution may not be possible but would have to probably be via the national level organizations.

2.3.3 OMG AI PTF: Artificial Intelligence Platform Task Force

The OMG AIPTF: Artificial Intelligence Platform Task Force focuses on enhancing efficiency through the application of various facets of artificial intelligence. The AI PTF is dedicated to developing foundational standards, including modeling of AI artifacts, knowledge representations, natural language processing, image and speech recognition, computer vision, robotic systems, virtual and augmented reality, advanced AI applications, machine and deep learning, neural networks, autonomous systems, and addressing security, privacy, and ethical impacts of AI.

The OMG (Object Management Group) standards are an industry rather than national standardization organization source of standards and as such may be easier to contribute to, if the effort is made at an opportune step of the lifecycle of a given standard.

2.3.4 ETSI (European Telecommunications Standards Institute)

The ETSI (European Telecommunications Standards Institute) is actively engaged in standardizing Artificial Intelligence (AI) technologies, recognizing their vital role in accelerating digital transformation across various market sectors. Within ETSI, the AI standardization activities are coordinated by the Operational Co-ordination Group on Artificial Intelligence (OCG AI), which oversees AI-related standards development. This occurs within ETSI's technical bodies, committees, and Industry Specification Groups (ISGs). These activities encompass designing and implementing AI in architectural models, enhancing information/data models, redesigning operational processes, increasing solution interoperability, and managing data for new ICT standards. ETSI's efforts in AI standardization also contribute to harmonized standards, crucial for legislative frameworks like the upcoming AI Act in Europe. Particularly applicable is the SAI series of standards. With respect to AI-PROFICIENT, a pertinent standard is:

2.3.4.1 Securing Artificial Intelligence (SAI) - Explicability and transparency of AI processing

Securing Artificial Intelligence (SAI); Explicability and transparency of AI processing ETSI GR SAI 007 focuses on explicability and transparency in AI processing, supporting the needs of AI platform designers and implementers who are called upon to ensure that the models and AI pipelines have these qualities.

This standard is of interest to AI-PROFICIENT as it is related to the efforts in the project to produce explainable AI models.

Artificial intelligence standards tend to be industry agnostic and focus on the technology, use and societal impact of AI. As such they are not as practical as industry specific models

2.4 Interoperability and Internet of Things (IoT)

As part of AI-PROFICIENT we used the MQTT IoT OASIS standard to develop communications support between edge devices and a broker as part of an industrial metrology software. We do not see any possibility of contribution to a standard from this work as we were a user of the standard which we did not need to extend or modify in any way.

We also performed a lot of practical interoperability (system integration) type of work, to get the existing factory data sources to send information into time series databases running in an in-plant cloud. While we encountered significant difficulties and had to spend considerable effort to implement, we do not see a way to generalize this effort into a standard set of rules or a generic architecture beyond what is adequately supported by existing cloud standards.

2.5 Ethics in Artificial Intelligence

As AI-PROFICIENT had a significant ethical design component, we considered the possibility of converting the lessons learned from this work into contributions to standards. In particular *IEEE 7000-2021 - IEEE Standard Model Process for Addressing Ethical Concerns during System Design* seems directly related to our work. This standard defines *the Concept of Operations (ConOps) and Context Exploration* and four processes: *Ethical Values Elicitation and Prioritization Process, Ethical Requirements Definition Process, Ethical Risk-Based Design Process and Transparency Management Process*. As our approach was along similar lines, focusing more on the Ethical Risk-Based Design Process, we considered how our approach aligned with the general process description in the standard. Note that to support ethical design, there was explicit ethics team feedback on every stage of the project design process.

2.5.1 IEEE P7000 Working Group Standards

The IEEE P7000 Working Group develops Ethics related AI standards. Contribution is via the IEEE process of standards development. In AI-RPOFICIENT we developed and approach of Ethics by Design and published our conclusions. The IEEE P7000 explicitly address ethical design. We have considered three standards that are of interest to AI-PROFICIENT and that we present in the next three subsections. The first is related to the project Ethics by Design concept. The second addresses transparency of control which we did not find the opportunity to explore in a factory setting mostly due to safety concerns. The third standard defines an ontology of concepts and terms in a quasi-formal way. It is not directly analogous to the more field-oriented work in AI-PROFICIENT but the taxonomy and definitions therein may inform ethics work in any follow-on projects.

2.5.1.1 7000-2021 - IEEE Standard Model Process for Addressing Ethical Concerns during System Design

IEEE 7000-2021 - IEEE Standard Model Process for Addressing Ethical Concerns during System Design, establishes a comprehensive process for integrating ethical considerations into system design and development. It guides engineers and technologists on including ethical values throughout the stages of concept exploration and development. It emphasizes a Values-Based Engineering (VbE) approach, enabling the elicitation, conceptualization, prioritization, and respect of end-user values in system design. The standard melds human and social values with traditional systems engineering and design.

2.5.1.2 7001-2021 - IEEE Standard for Transparency of Autonomous Systems

IEEE 7001-2021 - IEEE Standard for Transparency of Autonomous Systems, describes specific, measurable, and testable levels of transparency for autonomous systems. This standard, co-sponsored by the IEEE Vehicular Technology Society, the IEEE Intelligent Transportation Systems Society, and the IEEE Robotics and Automation Society, is designed to ensure that the behaviors of autonomous systems are understandable in terms of why and how they act as they do. The standard is mainly applicable to both physical and non-physical autonomous systems, including vehicles with automated driving systems and assisted living robots. It is used in assessing and determining the levels of compliance of autonomous systems with transparency requirements. In AI-PROFICIENT it is laterally related to the explainable AI work performed but we do not consider it a very promising candidate for contribution.

2.5.1.3 7007-2021 - IEEE Ontological Standard for Ethically Driven Robotics and Automation Systems

IEEE 7007-2021 - IEEE Ontological Standard for Ethically Driven Robotics and Automation Systems, is a definitions standard. These ontologies contain concepts, definitions, axioms, and use cases, all aimed at aiding the development of ethically driven methodologies for designing robots and automation systems. This standard applies to the robotics and automation domain, providing guidance during the development of these systems. It also serves as a foundational "taxonomy" to facilitate clear and precise communication among professionals from diverse fields, including robotics, automation, ethics, and related areas. Again, we do not see much potential for AI-PROFICIENT contribution to this standard. We include it because of the extent and quality of the quasi (semi) formal description of issues such as Transparency and Accountability or Ethical Violation management that can inform the evolution of ethical design principles.

2.5.2 ISO/IEC AWI TS 22443 - Guidance on addressing societal concerns and ethical considerations

The ISO/IEC AWI TS 22443 - Guidance on addressing societal concerns and ethical considerations is *a standard under development*. It is intended to provide guidelines for organizations to identify and address societal concerns and ethical considerations throughout the lifecycle of AI systems, providing organizations with tools to responsibly manage the societal and ethical implications of AI technologies.. As such it is a potential target standard for future contribution as part of follow up projects.

Contribution to an ethics related standard is not expected to convey any kind of direct commercial benefit to the industrial partners. Ethics is however an important area of academic research, extremely important from a social and legal standpoint and ethically validated models will probably soon be a legal requirement in Europe, at least in domains that are considered critical. The maturity of the ethics work in the project and its applied practical nature (as contrasted to more theoretical research) did not allow us to consider immediate efforts to contribute to a standard but does inform us about the need to consider standardization when incorporating ethics research in future projects.

3 Summary of actions undertaken during the project

3.1 Standardization Mind Map

As part of the project, we established a mind map of pertinent standards that we kept updating during the project as a primary working document. The top levels of this mind map are shown in the figure below:

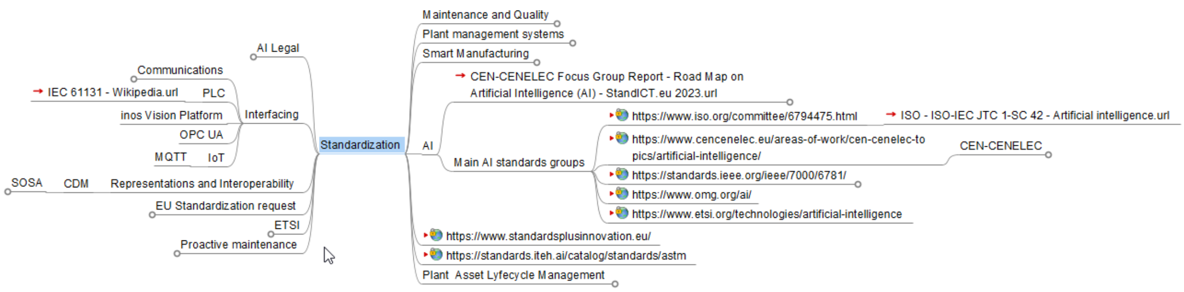

Figure 1: Top level of AI-PROFICIENT Standardization Mind Map

The use of the mind map has helped the consortium track the standards applicable to the project by easily adding and reorganizing information.

3.2 Standardization Session in WP7 periodic meetings

As part of WP7 and starting after month 18th of the project we have been conducting periodic meeting son a biweekly basis and when required on a weekly basis. During these meetings we have been discussing the developments of the project and the opportunities to target standardization activities based on them. The ones that seemed most promising were those connected with semantic modelling and we also explored the possibility of addressing industrial safety concerns.

3.3 HSBooster service support

We have applied and been accepted to be mentored on Standardization by the EU HSBooster service.

We had meetings with an advisor provided by HS Booster who presented her experience with standardization from previous projects. It was in these discussions that we understood the practical time scales of standardization activities and realized that the chances of actually contributing to a standard during the remaining 10 months of the project were limited. It seems that contributing to a standard requires not only a planned effort and budget but also must start from the beginning of a project, targeting standards groups with input based on previous work. Thes conditions were not met in AI-PROFICIENT, and we adopted our strategy to try and determine where we could contribute to follow-up projects and activities that exploit the results of the project.

In the initial meeting we described to the standardization project our project work and were introduced to the practicalities and long-time scales of the standardization process.

In a follow-up meeting we expanded on the standardization process, discussed the ISO/IEC JTC 1/SC 42 - Artificial intelligence group of standards, CEN-CENELEC JTC 21 - Artificial intelligence and the Eclipse AI, Cloud & Edge (AICE) Working group standards. We were introduced to the ETSI Industry Specification Group on Securing Artificial Intelligence (ISG SAI).

3.4 Meetings with other parties to pursue common standardization opportunities

We have organized a meeting in March 2023 with researchers from INRS (the reference body for risk prevention in France) to explore the possibility of working together in making a standards contribution. This group focuses on industrial safety. We determined that the subject matter of industrial safety as traditionally understood, is more or less incompatible with the concept of a data trained model that is at the core of current AI. This is mostly due to the fact that it is very difficult to model the behavior of data trained models in the traditional probabilistic manner that underlies traditional safety assurance that considers probabilities and magnitudes of undesirable events, aka risk. This is not to say that bridging this gap would not be an interesting area of research with possibilities of commercial exploitation. Unfortunately, the nature of the industrial datasets available in the project and the research and development planned and performed as part of AI-PROFICIENT precluded this. To assess whether there is evidence to support the above opinion formed as part of this discussion, we need to consider several factors:

1. *Nature of Conventional Industrial Safety:* Traditional industrial safety often relies on probabilistic risk assessment, which quantifies the likelihood and impact of potential hazardous events. This method depends on historical data and established patterns of equipment behavior, workplace accidents, and other safety-related incidents. In AI-PROFICIENT we have been using historical as well as real time data sets including discrete events, but they are not of a safety nature.
2. *Characteristics of Data-Trained AI Models:* AI models, particularly those based on machine learning, are trained on data sets to recognize patterns and make predictions. However, their behavior can be less transparent and predictable compared to traditional models, especially with complex algorithms like deep learning. This can make it difficult to apply conventional probabilistic methods for safety assurance. However, in AI-PROFICIENT we have made use of explainable AI techniques with a degree of success and the derived explainable models could potentially (with further work) be more amenable to conventional probabilistic analysis.
3. *The nature of many advanced AI models:* Unlike traditional models where inputs and outcomes are directly linked through known equations and probabilities, AI models can exhibit emergent behaviors that are not easily anticipated or quantified using traditional safety models. We have not noticed any significant emergent effects in our work, but we cannot conclude that under other circumstances such effects would not have arisen.
4. *Research and Commercial Exploitation:* The gap between traditional safety assurance methods and the behavior of AI models presents a research opportunity. Developing methods to better understand, predict, and manage the behavior of AI systems in industrial contexts could lead to significant advancements in AI safety and have commercial applications. This potential could be monetized through contribution to targeted standards that would allow both market acceptance and a first mover advantage.
5. *Industrial Datasets and R&D in the Project:* The nature of industrial datasets available in the project and the planned and performed R&D were not supportive of safety research but more appropriate for process optimization and industrial maintenance optimization research. The suitability of these datasets, along with the scope of R&D activities, are crucial in determining the feasibility of bridging the gap between traditional safety methods and AI models and in the case of AI-PROFICIENT they were not particularly suitable.

In conclusion, the development of new methodologies to align AI with traditional safety assurance practices remains an area for future research and innovation but is currently not mature enough to be compatible with the existing approaches to industrial safety.

This is an active area of research as evidenced by for example the presentations in the October 2022 Euroshnet Conference.

4 Plan for pursuing standardization post project

It is the aim of the AI-PROFICIENT consortium members to pursue avenues of standardization as part of follow up projects and the exploitation of the results of the project. To achieve this:

1. We have identified groups of standards matching specific technologies developed or used in the project (Table 1).
2. We have associated project key exploitable results with the above technology groups (Table 2).
3. We have created a mind map of the pertinent standards landscape.
4. We have analyzed the standards and standards in development that would be potentially the most interesting for the consortium members (as described in sections 2.1 to 2.5)

The final list of KERs from AI-PROFICIENT is shown in table 3 below.

Table 3: Final list of AI-PROFICIENT KERs and their links with categories of standards

	Outcome Name	Subjective estimate of possibility to contribute to a standard and related future focus	Applicable Targeted Standards
1	Surrogate Data Driven Explainable Model	Medium, Low	AI: ISO/IEC TR 24028:2020, ISO/IEC CD TS 6254 ETHICS: ISO/IEC AWI TS 22443, IEEE 7000-2021
2	Connected Worker Additive Check Application Using Innovative Human-Machine Interfaces	Low, Low, Medium	AI: ISO/IEC TS 4213:2022, ISO/IEC DTR 5469 MAINT: IEC 60300 Series ETHICS: IEEE 7000-2021
3	Quality Data Analysis: GO-QData	Medium, Medium	AI: ISO/IEC DIS 5259 ETHICS: IEEE 7000-2021
4	Machine Vision for Dimensional Measurement and Positioning with Small “Bad” Datasets	Low, Low	MAINT: SAE JA1011, ISO 13374, ISO 55000 Series ETHICS: IEEE 7000-2021
5	Data-Driven Predictive AI Analytics for Prognostics Based on DL	Medium, Medium	MAINT: ISO 13374, SAE JA1011, CEN EN 17485:2021, ISO 55000 Series ETHICS: IEEE 7000-2021
6	Natural Human-Computer Interaction	Medium	ETHICS: IEEE 7000-2021
7	Process Anomaly Detection: GO-QNormality	Low, Medium, High (Operator interaction)	AI: ISO/IEC CD TS 8200 MAINT: IEC 60300 Series, ISO 13374 ETHICS: IEEE 7000-2021

8	Multi-Objective Optimizer Generative and MI(N)LP Optimization Solvers	Low, Medium	MAINT: ISO 55000 Series ETHICS: IEEE 7000-2021
9	Semantic Accountability Tool	High (SOSA Model Specialization), Low, Medium-Low	SEM: W3C Semantic Sensor Network (SSN) Ontology AI: ISO/IEC AWI TS 17847, ISO/IEC DIS 5259, ISO/IEC CD 12792 ETHICS: IEEE 7000-2021

5 Conclusion

We as a consortium have, as originally planned, developed a structured approach to contribute to Standardization efforts.

We have considered the possibilities presented by the technologies we worked with and advanced. We have also considered the results of our project, which unfortunately become more concrete towards the end of the project.

We have tried to take advantage of mentoring offered by the HS Booster facility.

We have created a map of the standards landscape, selected specific standards and associated them with our project exploitable results.

We liaised with others that have an interest in standardization and tried to create a common avenue for contribution.

We determined that there was not enough calendar time once the results of our project became available to pursue contribution to a standards body within the duration of the project and focused on creating the foundations for potentially contributing to a standardization effort in follow up projects and activities.

We have mapped (Table 3) KERs to standards for further follow-up standardization work.

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