Handling with AI-enhanced Robotic Technologies for flexible ManUfacturing

D6.1- Dissemination, Exploitation and Communication Plan

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HARTU Consortium

HARTU "Handling with AI-enhanced Robotic Technologies for flexible manufactUring" (Contract No. 101092100) is a collaborative project within the Horizon Europe – Research and Innovation program (HORIZON-CL4-2022-TWIN-TRANSITION-01-04). The consortium members are:

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Public executive Summary

Dissemination, Exploitation and Communication of the HARTU project is based on identifying the different groups of key stakeholders interested in it and tailoring the communication of outcomes, news, and research results to fit the stakeholders' characteristics in terms of content, style and information support.

This document presents initial the dissemination, exploitation, and communication plan developed to promote the project and raising awareness and visibility about its progress and achievements.

This plan outlines the dissemination goals, the methodology behind it, the overall dissemination approach, and the channels used, and identifies the dissemination actions planned for the project duration. It is designed as a practical framework for day-to-day communications activities, which will range from the communication through the project's social channels and its website, to graphic activities, such as posters and brochures to be proposed at events where HARTU will participate. It includes a section devoted to the exploitation of HARTU's results, which includes a series of strategic activities and a structured methodology that will help to identify a detailed exploitation plan encompassing the project and the partners' needs. The document will be updated in accordance with the evolution and the needs of the project.

The document is organised into six sections. after a short overview of HARTU, and its main goals, giving, Section 1 is dedicated to the role of dissemination and the description of the dissemination strategy, based on the identification of the target audience and the approach chosen to reach it. Section 2 presents the dissemination actions planned throughout the duration of the project. Section 3 presents the strategic KPIs chosen to measure the success of the dissemination actions and keep track of the communication impact. Section 4 illustrates post-project actions envisioned to promote results and maintain stakeholders' awareness and engagement high beyond the project lifetime. In Section 5, the approach that will be adopted for the exploitation of HARTU's results is presented, followed by the introduction of the high level methodology that will be adopted for the market analysis and the updated list of Key Exploitable Results (KERs)In addition, preliminary individual exploitation plans of each partner are listed to highlight their ideas for exploiting project results and outcomes. Finally, Section 6 is dedicated to the objectives, actions and activities planned for the stakeholder's engagement.

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Acronyms

List of the acronyms	
AB	Advisory Board
AI	Artificial Intelligence
DIH	Digital Innovation Hub
EAB	External Advisory Board
EC	European Commission
IP	Intellectual property
ISO/TC	International Organization for Standardization/ Technical Committee
KER	Key Exploitable Results
KPI	Key Performance Indicator
R&I	Research & Innovation
ROI	Return on Investment
WP	Work Package

Project Overview

The HARTU project is an industry-driven research project that addresses the key challenges of parts handling, including grasping, assembly, and releasing, by leveraging innovative technical approaches.

The project will develop tools to achieve four main goals. Firstly, HARTU will establish self-supervised grasp and release planning policies identification and control. Secondly, it will teach and control contact-rich assembly skills from human demonstrations. Thirdly, HARTU will develop an AI-based multi-modal perception for visual-servoing and continuous monitoring in handling operations, supported by virtual and continuous learning. Finally, the project will create versatile and dexterous soft grippers with electro-active fingertips.

The project is driven by the industry and will include the deployment of technologies in five industrially relevant scenarios, including automotive, household appliances, hand tool manufacturing, food processing, and logistics. These scenarios offer a wide range of products in terms of shape, material, and size, enabling HARTU to increase the flexibility, reconfigurability, and efficiency of manufacturing lines. Additionally, HARTU aims to contribute to the user acceptance and adoption, identification of skills development needs, and compliance with the liability/legal and ethical aspects.

1. Dissemination Overview

Dissemination, communication, and exploitation activities represent a key part of the project. These activities are to convey information about the project, disseminate generated new knowledge, raise awareness across multiple communication channels and facilitate the acceptance of innovative solutions by end-users. Thereby, project results and outputs are open and available to interested people and key decision makers, to promote HARTU's achievements to all the potential interested parties.

HARTU aims at increasing the flexibility, reconfigurability, and efficiency of manufacturing lines, and, at the same time, contribute to user acceptance, adoption, and identification of skills development needs. Hence, a strategy focused on communicating the project and its findings to the relevant audiences is crucial to achieve the largest possible impact of the project.

Work Package 6 (WP6) is entirely dedicated to communication, dissemination, and exploitation tasks: a series of specific actions which are closely aligned with the different phases of the project, with the final aim of bringing EU-funded research and its results to the attention of multiple audiences.

The dissemination task spans the whole project duration (36 months), consistently communicating the project's progress and results, and engaging and involving all the categories of target audiences identified at the early stages of the project.

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HARTU's dissemination activities are designed to match the messages that need to be communicated with the right target audience, with the end goal of achieving awareness across a multi-layered community. To do so, the dissemination plan is based on five points, each one detailed in this document:

1. **Define the key messages and the dissemination goals:** identify the desired outcomes and the ways to achieve them (See section 2.1);
2. **Identify the different stakeholders:** find key targets interested in the project's outcomes and central for the success of it (See section 2.2);
3. **Tailor the information:** in terms of content, style and information support, personalise the communication message based on the interests and needs of the stakeholders (See section 2.3);
4. **Identify, plan and perform the communication and coordination activities:** build a clear and coherent strategy for the project communication that takes into account the goals, the target and the specific communication for each type of audience (See section 3);
5. **Measure the impact of communication and dissemination:** identify a set of indicators (KPIs) to keep track of the dissemination activities performed by the project and to monitor the progress of the dissemination. These indicators will help to determine if the dissemination strategy is achieving the expected results (See section 4).

1.1. Dissemination goals

The HARTU project's general objective is to provide components for automatic planning and control of grasping, release, and contact assembly tasks, proposing innovative gripping concepts based on electroadhesion for the handling of many different products. These components are integrated through a reference architecture and supported by perception capabilities and application development support tools, with the overall goal of making manufacturing lines more efficient, flexible and reconfigurable. They also can be split into three specific objectives: technological (TO), industrial (IO) and societal (SO).

The communication and dissemination parts of the project adopt an inter- and transdisciplinary approach to deliver these objectives. The key objectives are, on one hand to engage stakeholders and end-users to raise awareness and social acceptance, and on the other hand, to communicate the milestones, the results and HARTU's outcomes. The success of the dissemination tasks is also related to the communication extension to the widest possible audience of stakeholders that will adopt and validate the project's results.

Depending on the phase of the project and on the stakeholders expected involvement, the dissemination activities' aim is to:

1. **grant visibility to the research at all levels**, with communicable content to be widely spread to the policy makers and relevant stakeholders and communities;
2. **create a community of interested stakeholders and contribute to increased acceptance of the developed solutions,** to ensure that the project is well received, more likely to be adopted and effective in achieving its intended goals;

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3. **provide increased acceptance** of HARTU's developed solutions by end-users according to ethics, safety and regulatory frameworks;
4. **make project results available to the scientific community, potential industrial partners, and policy makers,** thanks to a tailored and specific communication and dissemination strategy; and
5. **define the exploitation plan for the project results,** to ensure that the project's results are effectively used and have the maximum possible impact.

1.2. Target audience

The communication of HARTU's results to a specific target audience is crucial to clarify the purpose and scope of the project. It helps to focus on the needs and requirements of the public and to tailor the project objectives, strategies, and messages accordingly. Knowing the target audience also enables to communicate more effectively with stakeholders, end-users, and policy makers.

As previously stated, strategic communication relies on the clarification of objectives, audience, and message before deciding on which media information could be transmitted. The HARTU dissemination plan is designed to match the messages to be communicated with the target audience and the means used, with the end goal of achieving awareness, increase acceptance, and grant visibility.

The HARTU target audience has been categorised under four main clusters, each having a different level of interest in the topic:

1. **International industry,** interested in the innovations and technologies developed within the project for potential adoption of the new handling and assembly technology in different kinds of sectors, including:
   a) Sectors involved in HARTU, such as industrial manufacturing and logistics companies, system integrators and application builders, robot manufacturers and automation industry;
   b) Sectors not involved in HARTU, such as aeronautics, naval and automotive supply chain manufacturing industries, etc.
2. **Scientific community at international level**
   a) Universities and research centres that are investigating robotics, advance manufacturing, logistics, and artificial intelligence: this audience is made up of people working in HARTU's area of expertise, who can contribute to the research and have a great interest in the results and developments of the project.
3. **Standardization and regulation bodies, policy and decision makers** to which HARTU would provide relevant information concerning the results of the most recent research initiatives:
   a) European Commission
   b) Standardization bodies, e.g., NIST and ISO/TC 299, who develop high quality standards for the safety of industrial robots and service robots to enable innovative robotic products to be brought onto the market. HARTU wants to communicate with them to ensure that the growth of the robotic market is compliant with the current and new standards
   c) Entities dealing with ethics

4. **End users,** especially people interested in the topic of our research, and workers who fear and do not trust AI based robotics. The goal is to involve this key audience to increase acceptance and collect specific needs and requirements. End users from the other funded projects under the same call, **i.e.,** SmartHandle, Masterly, and AgileHand, will be also approached for the technology awareness and dissemination activities.

These four categories of audience are expected to use the HARTU information in different ways. As a result, different information may require different dissemination means and activities, using different languages, content types and levels of detail for each specific target. In such a way, the dissemination and networking strategy will ensure that the dissemination effort is tailored, touches the right target audience, and produces a specific type of utilisation.

1.3. Dissemination approach

The HARTU dissemination plan will identify the most appropriate set of means for each category of stakeholders. In the previous sections the main project goals and target audience have been identified. The next steps will be:

- the identification of the target audience's characteristics and needs,
- the selection of the results to be communicated,
- the identification of the proper content, means, formats, and language style to get the desired outcomes in terms of dissemination and communication objectives.

The dissemination strategy must be planned and carried out as a long-term activity to allow the community of reference to mature their knowledge along with the evolution of the project.

A key role in the dissemination strategy is played by the project's graphical identity: each communication activity within HARTU must be clearly recognisable and easily associable to the project itself. For this reason, the Consortium designed a dissemination pack for internal and external communication containing the project logo and logotype, and deliverables, presentations and posters templates.

The main steps considered in the HARTU's dissemination strategy concern:

- The analysis of the peculiarities and interests of the main clusters of stakeholders presented in section 2.2, and the identification of the reactions intended to be achieved through the project communication. This will help the consortium in fitting the information to broadcast to the stakeholders' characteristics and expectations, since the communication is directed towards different targets, coming from different backgrounds.

- The definition of the content to be promoted related to the findings of the project. The content of the dissemination will evolve during the project, and the means of disseminating information may change as well. The informative contents will mostly be promoted through graphic support, social media channels and the website, while the communication of technical results will be supported by more specialised means, such as scientific articles,

webinars, presentation at conferences, seminars, and fairs.

- The implementation of dissemination activities based on the status of the project and target audience, the evaluation of the project and the necessities of the moment.

1.3.1. Coordination and networking with other H2020 and HE projects

To ensure its success and visibility, the HARTU project will collaborate and create synergies with other projects and initiatives in the Horizon Europe Programme. Collaborating with projects that have similar goals or are in the same field of research can be significant to HARTU's success. Sharing results can help the project's growth, share lessons learned, and contribute to the research of sister projects in the field.

A preliminary list of potentially interested research and innovation project has been compiled and will be monitored during the project lifetime:

Table 1 - List of R & I running projects relevant to HARTU

Research and Innovation projects	General information	Description
Artificial Intelligence in Manufacturing for Sustainable Applications at SMEs	ARISE https://cordis.europa.eu/project/id/101092312 January 2023 – June 2026	The project will support European SMEs in the uptake of Artificial Intelligence applied to manufacturing, with a specific focus on the use of AI-enabled applications at the edge.
Cervera network of robotic technologies in intelligent manufacturing	5R https://red5r.es/ January 2021 – June 2024	The project wants to promote the introduction in the manufacturing sector of new paradigms of flexible and collaborative robotics supported by artificial intelligence.
COGNitive Industries for smart MANufacturing	COGNIMAN https://cordis.europa.eu/project/id/101058477 January 2023 – December 2026	The project will provide the means to facilitate flexible, resilient, reconfigurable, safe, sustainable, and efficient smart manufacturing by integrating key technologies. Development of a machine learning toolbox and cognitive robotics integrated in human-centric modular

		toolboxes that can be easily adapted to substitute manual manufacturing processes
Digital Intelligent Modular FACtories	DIMOFAC https://cordis.europa.eu/project/id/870092 October 2019 – March 2024	The project is a European initiative that came to life to help factories implement a smart factory architecture that will allow them to be more reactive to a personalised demand and changing market dynamics.
Explainable Manufacturing Artificial Intelligence	XMANAI https://cordis.europa.eu/project/id/957362 November 2020 – April 2024	The project focuses on explainable AI. It will carve out a 'human-centric', trustful approach that will be tested in real-life manufacturing cases.
Manipulation Enhancement through Robotic Guidance and Intelligent Novel Grippers	MERGING https://cordis.europa.eu/project/id/869963 November 2019 – April 2023	The project aims to provide manufacturers with a versatile, easy-to-use and low-cost solution to automate the handling of flexible and fragile objects. It addresses challenges such as handling of soft materials in the food sector, among other sectors.
multipurpose robotics for mAniPulation of defoRmable materIaLs in manufacturing processes	APRIL: https://cordis.europa.eu/project/id/870142 April 2020 – March 2024	The project is developing autonomous, dexterous and market-oriented robot prototypes to innovate the manufacturing of flexible and deformable materials in European enterprises. It addresses human-robot interactions carrying out tasks pertaining the handling process of **soft materials** in the **food sector,** among other sectors.

Nimble Artificial Intelligence driven robotic solutions for efficient and self-determined handling and assembly operations	MASTERLY https://cordis.europa.eu/project/id/101091800 January 2023 – June 2026	The project aims to develop flexible robotic solutions, constituting of modular grippers combined with state-of-the-art robotic technologies, enhanced with AI driven advanced control and perception capabilities. It will allow them to act autonomously, handling a large variety of parts varying in size, shape and material, while being acceptable by both genders of workforce.
Smart Grading, Handling and Packaging Solutions for Soft and Deformable Products in Agile and Reconfigurable Lines	AGILEHAND https://cordis.europa.eu/project/id/101092043 January 2023 – December 2025	The project aims at developing advanced technologies for grading, handling and packaging autonomously soft and deformable products, as a strategic instrument to improve flexibility, agility and reconfigurability of production and logistic systems of the European manufacturing companies.
SMARTHANDLE. Resilient manufacturing lines based on smart handling systems.	SMARTHANDLE https://cordis.europa.eu/project/id/101091792 January 2023 – December 2025	The project will research technologies to support the European industry, by implementing a) intelligent, reconfigurable agents to provide dexterity in a range of handling applications, b) AI based reasoning enablers to optimize the flexibility potential of these agents and c) Higher-level planning and coordination mechanism to allow the successful and scalable deployment of such solutions in real life use cases.

2. Dissemination Actions

The dissemination of the HARTU project will be a collaborative activity managed by Deep Blue and supported by the whole consortium, to ensure an effective diffusion of information. Partners will help to identify the different target audiences and domain-specific channels in their countries and will provide an individual exploitation plan to understand how the project can be exploited on multiple levels (see section 5). Tailored messages will enhance engagement; for example, different kind of brochures, posters and online graphics could reach different types of stakeholders. An initial planning for the dissemination actions is presented below; however, all the listed dissemination means will be updated throughout the duration of the project, and the contents and tone of messages can be adapted to the specific dissemination activity, since each dissemination mean is expected to have a different impact on the target audience and will be used to achieve different dissemination goals.

2.1. Dissemination pack

The dissemination pack is composed of a set of products associated with the project image to ensure consistency to the project communication. It will be a practical framework shared with all HARTU partners and updated throughout the project duration when needed. It comprises:

1. The project logo
2. The style guide
3. Social media covers
4. The document templates

Firstly, the logo was designed to offer a conceptual representation of the project, meaningful to its objectives and aesthetically appealing. An initial logo was created for the first official meetings. Redesigns and new proposals were then made and circulated among the partners to choose what the final logo would be. It was decided to stay with the initial logo because it was representative of the concept of the project, since the pictogram resembles a robotic handle grasping the letter "A" of the acronym. The gradient of colours from darker blue to lighter blue wants to convey calm and reassurance but also indicates technology and technological progress. Additionally, this logo was chosen because it is compact and agile to fit into the various graphic representations of the project.

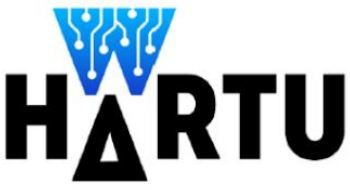

Figure 1 - HARTU's initial logo

Figure 2 - HARTU's initial logo restyling

Figure 3 - HARTU's initial logo new proposal

The final version of the logo (Figure 1) was chosen by partners after the official kick-off meeting in February 2023.

As second step, a style guide for the logo usage was outlined. It contains the colour palette (Figure 4), the official project fonts (Figure 5), and all the graphic settings that could be necessary in the dissemination products (Figure 6). The creative process has been carried out by the Deep Blue graphic team, with different iterations and feedback collection steps involving the consortium.

Figure 4 - HARTU's colour palette

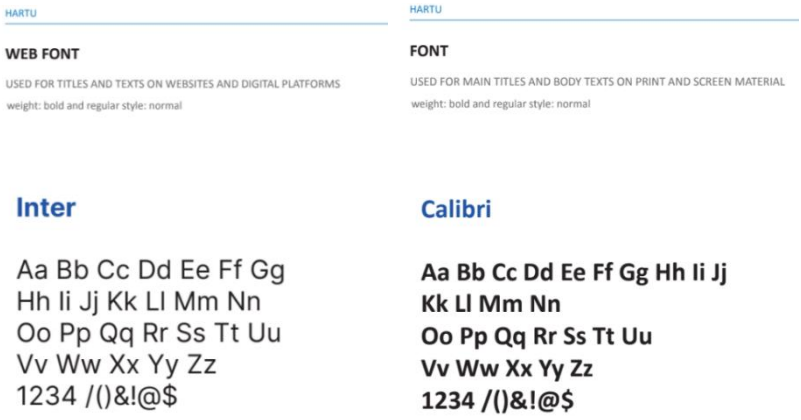

Figure 5 - HARTU's fonts

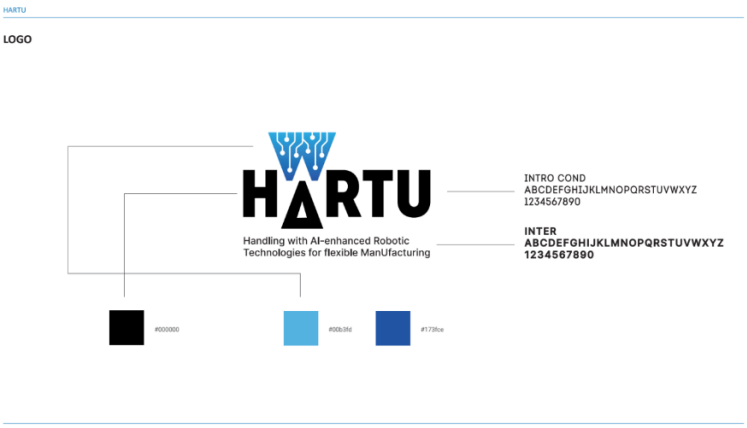

Figure 6 - HARTU's graphic elements

Once the overall visual identity has been defined, it was applied to the social media covers and the document templates.

Social media pages, along with the website, will be the main communication channels of the project, the places where audiences and user communities can find useful information, so it is important that they are developed based on the visual elements of the project; while working templates are crucial to reinforce the common language used by HARTU. Templates for deliverables, presentations, and posters have been provided, together with the visual identity materials that will be used throughout the whole project duration and that will be easily adapted to the needs of the consortium partners.

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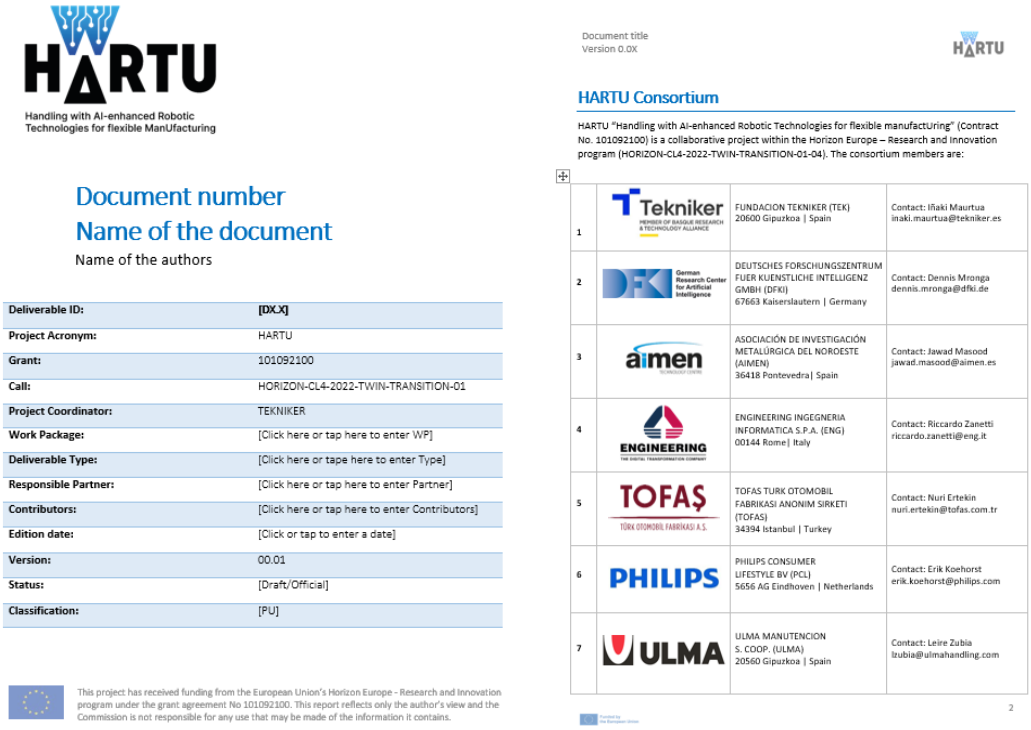

Figure 7 - HARTU's documents template

Figure 8 - HARTU's presentation template

Figure 9 - Icon and social logo

2.2. Brochures, flyers, and poster

On the occasion that HARTU participates in public events, printed flyers and brochures will be produced to present its goals, outcomes, and findings. The brochures will be tailored to the type of conference and objective of the communication; the textual content will be agreed with the partner attending the conference. The brochures and flyers will always be up to date, and available for download on the website. HARTU will also have an official poster that will be used whenever possible during public events.

2.3. Presentations

Presentations will be prepared for the participation in conferences, workshops, third-party events, and internal meetings. The presentations for external events should focus on little textual information and will have a predominantly graphical aspect to engage the target audience. They will always include the main project references such as the link to the project website, social media pages and contacts. Presentations will be stored in dedicated repositories and made available on the website for free download.

2.4. Videos

Two project videos will be produced to disseminate project objectives and results. A project presentation video will be produced during HARTU's first phase (M1-18), and a preliminary results video will be published during the second phase of the project (M19-36). Videos are very well-suited to deliver information in an effective and immediate way and are often considered one of the best options to raise awareness.

They will be distributed through various channels (e.g., HARTU's YouTube channel, social networks, project and partners' websites) and, whenever possible, shown during public events or conferences.

2.5. Website and news

The HARTU website will represent the main dissemination channel for the project, providing a comprehensive overview of the project objectives, its planned activities, and its results. The website will be updated constantly with news about the project, progress, organisation of or participation in events, incoming workshops and any other announcement related to HARTU. It will also serve as a repository of relevant documents, public deliverables, publications, and dissemination materials. The project partners will support this task by sharing relevant updates whenever possible.

Deep Blue is responsible for the design, realisation, maintenance, and update of both the website and the social network profiles.

Both the structure and the external appearance of the website are developed considering the highest usability standards, ensuring a clear and easy navigation for all kinds of users and from all devices thanks to responsive design. The website structure and contents is illustrated in Fig. 10 and can be summarised as follows:

- **Homepage**

- Project overview
- Objectives
  - Tecno-industrial
  - Societal
- Timeline - Focused on the results
- Consortium - Partners bio
- Carousel with project news
- Newsletter

- **About**
  - Context and Concept
  - Use cases
  - Expected results
  - Sister projects
- **Resources**
  - Results
  - Scientific Publications
  - Promotional Materials
  - Data repository
- **News**
  - Newsletter
  - News and Events

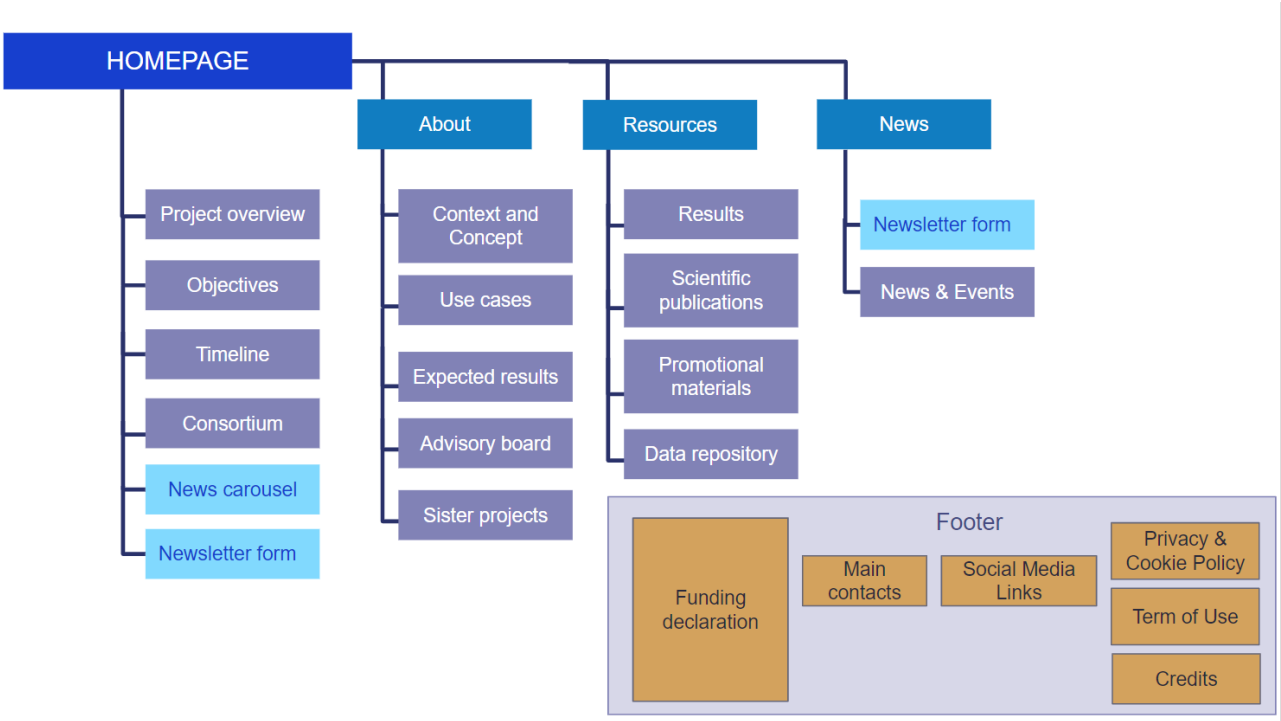

Figure 10 - Website structure

From a technical point of view, in order to develop a secure, reliable and dynamic website, a professional hosting service providing a database service (MySQL) and backup features was chosen. The website has been developed using a Content Management System (CMS) technical platform

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that allows for an easy management of the contents and the sections of the website. Among the CMSs available, we selected the one considered the most reliable, supported from a documentation point of view and flexible, Wordpress[1]. In order to improve the HARTU website positioning on the major search engine, Search Engine Optimisation (SEO) functionalities were enabled. This functionality increases the possibility of being correctly identified and proposed to users by search engines.

Matomo Analytics[2] tools will be used to monitor the website usage and accesses. It provides statistical information about the website: visitors, traffic sources, most viewed content, etc. It is a helpful tool to identify possible issues, increase efficiency, and evaluate the website's impact and effectiveness.

Concerning GDPR (Eu regulation 2016/679) compliance, the website will refer to Iubenda[3] with Deep Blue acting as data controller. The types of personal data collected by this application include: email addresses; first name; last name; usage data and cookies. The website only collects the personal data strictly necessary, freely provided by the users, or, in case of usage data, collected automatically when navigating the website.

2.6. Scientific articles and papers

During the lifetime of the project, it is expected that 18 scientific publications will be released as Gold Open Access: six in the first phase (M1-18), twelve in the second one (M19-36). These scientific and technical publications must be published on international peer-reviewed scientific journals to ensure the quality and accuracy of the research.

HARTU will follow the European guidelines on the large-scale accessibility of project findings. Gold Open Access publishing will be granted to all scientific publications resulting from the project. Less technical articles aimed at a wider audience will also be published on EC channels.

Table 2 - List of provisional scientific peer reviewed journals

Scientific peer reviewed journals	
Advanced Intelligent Systems	https://onlinelibrary.wiley.com/journal/26404567
CIRP Annals	https://www.sciencedirect.com/journal/cirp-annals
Extreme Mechanics Letters	https://www.sciencedirect.com/journal/extreme-mechanics-letters
IEEE Access	https://ieeeaccess.ieee.org/

[1] www.wordpress.org
[2] https://matomo.org/
[3] www.iubenda.com

IEEE Robotics and Automation Letters	https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=7083369
IEEE Transactions on Robotics	https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=8860
International Journal of Robotics Research	https://journals.sagepub.com/home/ijr
Journal of Field Robotics	https://onlinelibrary.wiley.com/
Nature Machine Intelligence	https://www.nature.com/natmachintell/
Robotics and Automation Letters	https://www.ieee-ras.org/publications/ra-l
Robotics and Autonomous Systems	https://www.sciencedirect.com/journal/robotics-and-autonomous-systems
Robotics and Computer-Integrated Manufacturing	https://www.sciencedirect.com/journal/robotics-and-computer-integrated-manufacturing
Science Robotics	https://www.science.org/journal/scirobotics
Sensors	https://www.mdpi.com/journal/sensors

Table 3 - List of provisional EC Channels

EC Channels	
AI, Data and Robotics Association (Adra, asbl)	https://adr-association.eu/
CORDIS	https://cordis.europa.eu/
H2020 The EU R&I magazine	https://ec.europa.eu/research-and-innovation/en/horizon-magazine
Open Research Europe	https://open-research-europe.ec.europa.eu/

2.7. Social networks

For disseminating the project outcomes, the consortium has chosen to use the following social media networks: LinkedIn, Twitter, and YouTube. These channels help open discussion around the project topics, not only among a specialised audience but also involving the general public. The effectiveness of these dissemination means will be periodically evaluated to compare communication strategies and get a comprehensive picture of what is working and what is not.

The three social media were chosen with different aims:

- LinkedIn[4], as a professional social network, attracts a group of interested professionals, stakeholders, policy makers and end-users that can exchange information and discuss about the project and its findings. The information shared via LinkedIn will be as informative as possible: thanks to the longer format that the platform allows, it will be possible to discuss certain topics more extensively and create discussions in the comments section.

- Twitter[5] supports short and focused communication, so it will be used to promote news about the project (e.g., participation to events, deliverables released), relevant information and to interact with key actors for the project.

- YouTube[6] is a platform for publishing videos and enjoying them easily and for free. It will be used to publish HARTU's project videos.

As the three channels strongly differ from each other, they must be used in different ways. To ensure a successful communication, the project's tone should adopt a friendly yet professional tone, even while sharing technical and scientific information. Using a clear and concise language to explain technical concepts and ideas, will make the message more agile to take in, considering the speed of social networks. Scientific content from the technical tasks of the project will be analysed and transformed into communicable content to be widely spread to the policy makers and relevant stakeholders and communities.

In the following table, a list of the partners' social media handles is provided:

Table 4 - Partners social media handles

Partners social media handles	LinkedIn	Twitter
TEKNIKER (TEK)	@Tekniker	@TeknikerOficial
DEUTSCHES FORSCHUNGSZENTRUM FUER KUENSTLICHE INTELLIGENZ GMBH (DFKI)	@DFKI	@DFKI
ASOCIACIÓN DE INVESTIGACIÓN METALÚRGICA DEL NOROESTE (AIMEN)	@AIMEN Centro Tecnológico	@aimenct
ENGINEERING INGEGNERIA INFORMATICA S.P.A. (ENG)	@Engineering Ingegneria Informatica Spa	@EngineeringSpa
TOFAS TURK OTOMOBIL FABRIKASI ANONIM SIRKETI (TOFAS)	@TOFAS	NA
PHILIPS CONSUMER LIFESTYLE BV (PCL)	@Philips	@Philips
ULMA MANUTENCION S. COOP. (ULMA)	@ULMA Handling Systems	NA

[4] HARTU's LinkedIn page: https://www.linkedin.com/company/hartu-project/
[5] HARTU's Twitter page: Twitter link: https://twitter.com/HARTU_project
[6] HARTU's YouTube page: https://www.youtube.com/channel/UCZRaIkULYephAant7vG0uJQ

DEEP BLUE (DBL)	@Deep Blue	@dblue_it
FMI HTS DRACHTEN B.V. (FMI)		NA
TECNOALIMENTI S.C.p.A (TCA)	@Tecnoalimenti s.c.p.a	/
POLITECNICO DI BARI (POLIBA)	@Politecnico di Bari	@PolibaOfficial
OMNIGRASP (OMNI)	@Omnigrasp	@omnigrasp
INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE INCORPORATED (ITRI)	@Industrial Technology Research Institute	@ITRI_Taiwan
INFAR INDUSTRIAL Co., Ltd (INFAR)	NA	NA

A list of the official project hashtag is presented in the table below. Hashtags are useful to link any kind of content published on HARTU's pages to the appropriate topic. This feature is helpful to reach the right audience. Therefore, a social content will always be related by one of the following hashtags or a combination of them.

Table 5 - List of official project hashtags

Official project hashtags
#AI
#Efficiency
#Flexibility
#Grasping
#Handling
#HARTU
#HorizonEurope
#HumanRobotInteraction
#Industry
#Innovation
#Manufacturing
#RoboticManipulation

2.8. Newsletter

At least once every six months, a project e-newsletter will be sent to partners, key stakeholders, specific audience, and all the contacts who have subscribed to the form on the website. The newsletter's aim is to keep the audience interested and informed about activities and results, with insights, useful links, and interesting readings. For specific information, targeted newsletters can be sent only to certain clusters in the contact audience.

For the delivery and management of contacts - including their privacy in compliance with the GDPR regulation (EU 2016/679) - a MailerLite[7] account will be opened. MailerLite is a reliable and secure tool which guarantees transparent opt-in/opt-out choices to subscribers and supports a simple customisable design and effective delivery.

In order to boost the number of subscribers, a link to a subscription form will be available on the project's website homepage. Contacts will also be collected during webinars, events, and workshops, obviously under prior consent.

2.9. Press releases

Press releases are official statements that are sent to targeted members of the traditional news media to announce newsworthy contents or results to be promoted. A press release is a short, compelling news story, whose goal is to catch the interest of a journalist or publication. At least three press releases will be shared during HARTU's lifetime: the first at the beginning of the project, to announce the launch of the project gain visibility, and start collecting followers; the second at the mid-point of the project to update on HARTU's status and present the first goals achieved; the last one at the end of the project, to summarize what HARTU accomplished, the new technologies developed, the future of AI in the manufacturing, etc.

In May a general press release was produced and made available for all partners to utilise and customise according to their needs. This press release was designed to maximise visibility and reach a wider audience through various national media. Partners were encouraged to make use of this document to amplify their presence and increase their visibility within their respective markets. By sharing this press release through national media channels, HARTU aims to collectively enhance its visibility and generate greater exposure for all partners involved.

2.10. Events

Different types of events will be held and organized to gather input and to report to the audience what HARTU is doing. Partners will also participate in live events, conferences, and fairs to understand what is new in the manufacturing sector, raise awareness on the project, and forge relationships and synergies.

In fact, participating in or organizing events is crucial for this kind of projects, as it helps the project to grow and to understand the needs to be addressed.

2.10.1. Public events

All consortium members are committed to attend European and international networking conferences and internal project events, in order to disseminate HARTU's activities and results. The objective is to help raise awareness of the project among a specialised audience and enlarge the pool of stakeholders.

[7] www.mailerlite.com

Table 6 - List of events to be organised

Events to be organised by HARTU	Description	Overall
Open days	Virtual open days reaching 200 interested companies	2
Dissemination event	One dissemination event (M18) organised, if possible, in synergy with an existing event	1
Final dissemination event	At the end of the project (M36) to present the results of the project to EC officials, policy makers, stakeholder community, relevant bodies and associations from different sectors	1

A preliminary list of events and conferences to be targeted can be found below. Further events will be identified during the project.

Table 7 - External Events, Conferences and Fairs

External Events, Conferences and Fairs to attend	Date	Website
AUTOMATICA	June 27 – 30, 2023	https://automatica-munich.com/en/
BIEMH	June 3-7, 2024	https://biemh.bilbaoexhibitioncentre.com/
BI-MU	October 9 – 12, 2024	https://www.bimu.it/en/
Cibus Tec	October 24 – 27, 2023	https://www.cibustec.it/it/home/index.php
ERF 24	March 13-15, 2024	https://erf2024.eu/
EuroEAP	6-8 June 2023	http://www.euroeap.eu/index.php/euroeap-conference-home
European Robotics Forum (ERF)	March 14 – 16, 2023	https://erf2023.sdu.dk/
IEEE International Conference on Robotics and Automation (ICRA)	May 29 – Jun 2, 2023	https://www.icra2023.org/
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)	October 1 – 5, 2023	https://ieee-iros.org/
IEEE-RAS International Conference on Soft Robotics (RoboSoft)	April, 3 – 7 2023	https://softroboticsconference.org/

International Joint Conference on Artificial Intelligence	August 19 – 25, 2023	https://www.ijcai.org/
International Machine Tool Exhibition (BIEMH)	June 3 – 7, 2024	https://biemh.bilbaoexhibitioncentre.com/en/
TUTTOFOOD	May 8 – 11, 2023	https://www.tuttofood.it/

2.10.2. Workshops and webinars

Workshops are effective means for involving end-users and stakeholders in every stage of the research, collect inputs, and steer the work of the project in the most effective direction. Feedback from these sessions will be used to improve both HARTU communication impact and its technical approach. Collaboration with ongoing projects and platforms in the field, through workshops in the context of public events, will allow to broaden the project's perspectives and to exploit its outcomes properly.

Table 8 - List of workshops to be organised

Workshops	Description	Overall
Workshops in the form of webinar	One per year. It will showcase the HARTU approach and solutions to key stakeholder groups	3

2.10.3. Internal dissemination

The internal communication strategy will focus on raising interaction and knowledge transfer between partners and ensure the success of the project. Partners will interact and organise regular teleconferences and other multi- and bi-lateral contacts will be held with other partners. Furthermore, the project will make use of a number of project management tools to maximise the effectiveness of internal communication and collaboration between partners:

- The Microsoft TEAMS tools will be used to stay in contact with the consortium. Especially, the SHAREPOINT tool will be used as an open access file repository and file sharing platform;
- Teleconferences and video conferences systems for periodic update meetings;
- Regular monthly dissemination meetings have been planned to maintain a coordinated and cohesive approach to the project's dissemination. The monthly update meetings for WP6 facilitate effective communication, alignment with project objectives, problem-solving, and enhance the possibility of sharing knowledge and resources among partners. They are useful to enhance the impact and success of the project's dissemination efforts.

Efficiency, timeliness, and ease of interaction are the main objectives of this activity: any issues and inconveniences will be promptly addressed and solved to ensure continuity.

3. Monitoring and KPIs

Monitoring communication and dissemination activities is a critical aspect of achieving success and maximizing the impact of any communication strategy. By monitoring a communication campaign, HARTU can assess the effectiveness of its messages, adjust its strategies based on real-time feedback, and ultimately achieve its communication objectives. Additionally, monitoring a communication activity helps to identify areas for improvement, for future actions.

It is important to set some measures which will be used to know if this dissemination strategy is achieving its aims. Several KPIs have been identified to keep track of the progress of the dissemination.

Table 4 below presents a cumulative list of all dissemination and communication Key Performance Indicators for the HARTU project, corresponding to activities and measures presented in the plan.

Table 9 - Dissemination and Communication KPIs

KPIs for Dissemination & Communication activities	Phase 1 (M1 – 18)	Phase 2 (M19 – 36)	Overall
Number of events to be organized (open days, final dissemination event, webinars)	2	4	6
Number of external events (dissemination event)	1	0	1
Presence at fairs	1	2	3
Presence at conferences	3	7	10
Focus groups/meetings (remote) with stakeholders	5	7	12
Number of synergies created with other relevant H2020 and HE projects	4	6	10
Number of articles published (including scientific publications as Open Access)	6	12	18
Number of press releases delivered to traditional media	1	2	3

Number of unique visitors to the website (based on Google Analytics)	1000	3000	4000
Social media followers (LinkedIn and Twitter)	200	300	500
Project videos	1	1	2

These measures can be refined, updated, and integrated during the project evolution, according to the needs that may be encountered during the project.

4. Post-project dissemination

After the project ends, the website will be updated with the latest information and resources available. It will be maintained for two more years. Similarly, the social media profiles will follow-up communication about most recent results and newsworthy updates for about three months. Moreover, a closing blogpost will inform the audience about the project's legacy. Results, articles, and useful resources developed during the project will remain available for download and reference.

5. Exploitation plan

Developing an exploitation plan is important for maximizing the impact of the research, meeting funder requirements, creating a clear pathway to impact, engaging stakeholders, and promoting sustainability. It helps to ensure that the research outcomes are effectively disseminated and utilized, and that the benefits of the research are realized.

During the HARTU project a set of specific actions will be undertaken to ensure a comprehensive and effective exploitation of project results and outcomes, in particular:

- an **Articulated Exploitation Plan,** to be considered as a clear guideline to guarantee market exploitation of the results, will be delivered indicating the full exploitation strategy, return on investment analysis, timeline and main actions to be conducted by partners well after the project.
- a detailed joint **Exploitation Agreement** (that will integrate the Consortium Agreement) will be defined among partners to establish clear commercial routes and relevant granted and agreed rights to exploit project results and knowhow in the defined market providing commercial opportunities for all involved parties.
- a **Return-on-Investment study** to analyse what kind of return on investment can be foreseen by an organisation (or set of organisations) adopting the HARTU solutions. This analysis will

conduct a comprehensive return assessment (not exclusively monetary) considering aspects such as increased reputational aspects, social/economic costs, etc. The ROI Study will help validating the project results from a business/impact point of view and finalizing a value proposition and a business case.

Exploitation activities will start early in the project and will follow an Exploitation path evolving within the project. This path will be divided into three phases, each of which corresponds to a serie of strategic actions aimed at the best and most fruitful exploitation of project's results.

- **Initial phase (M1- M6)**

  In this phase a Preliminary Market Analysis is carried out. The roadmap that will lead to complete the Market Analysis (from M6 to M36) is described (Section 6.1), the Key Exploitable Results (KERs) from the proposal were revised together with the partners (Section 6.2). A document for the market analysis with different sections to be explored by M18 was drafted, and a preliminary state of the art on the market trends related to robots and AI in the manufacturing sector was carried out (Section 5.3). The state of the art will be analysed more in detail during the mid phase of the exploitation path, concentrating on delivering a state of the art relevant to the KERs to be exploited.

- **Mid phase (M6-M18)**
  In this phase the initial business and exploitation plan will be outlined and validated with the stakeholders, while the market analysis will be defined with the support of each partner who will be consulted during workshops and focus groups. A more detailed and truthful project Business Model Canvas will be developed, and a specific Business Model Canvas will be elaborated for the main solution associated to each market segment.
- **Final phase (M18-36)**

  Within the last months of the project, the final assessment of HARTU exploitable results and assets will be finalised. Then, the ROI analysis will be carried out, as will the exploitation agreement and the finalised business case. These analyses will be performed addressing the areas of the Business Model Canvas, with a ROI-driven point of view.

To boost HARTU's dissemination and exploitation activities and results, a series of EC platforms and services will be taken into consideration:

Table 10 - List of EC platform to boost exploitation and dissemination activities

Name	Description	Website

European IP Helpdesk	A first-line IP service providing free-of-charge support to help European SMEs and beneficiaries of EU-funded research projects manage their IP	https://intellectual-property-helpdesk.ec.europa.eu/regional-helpdesks/european-ip-helpdesk_en
EFFRA – Innovation Portal	Industry-driven association promoting the development of new and innovative production technologies. EFFRA has been representing the private side of the manufacturing partnership with the EU Commission.	https://www.effra.eu/
Horizon IP Scan	Helping SMEs to manage and valorise Intellectual Property (IP) in R&I collaborations	https://intellectual-property-helpdesk.ec.europa.eu/horizon-ip-scan_en
Horizon Results Booster	To boost the exploitation potential of the research results, disseminate effectively, and go to market.	https://www.horizonresultsbooster.eu/
Horizon Results Platform	To promote your Key Exploitable Results	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform
Innovation Radar	Discover cutting-edge EU-funded innovations being developed by Europe's leading researchers and innovators	https://innovation-radar.ec.europa.eu/

5.1. Market Analysis methodology

To deliver a Market Analysis by M18, the roadmap illustrated in Figure 11 will be followed (in line with the approach defined for the three phases previously defined in Section 5):

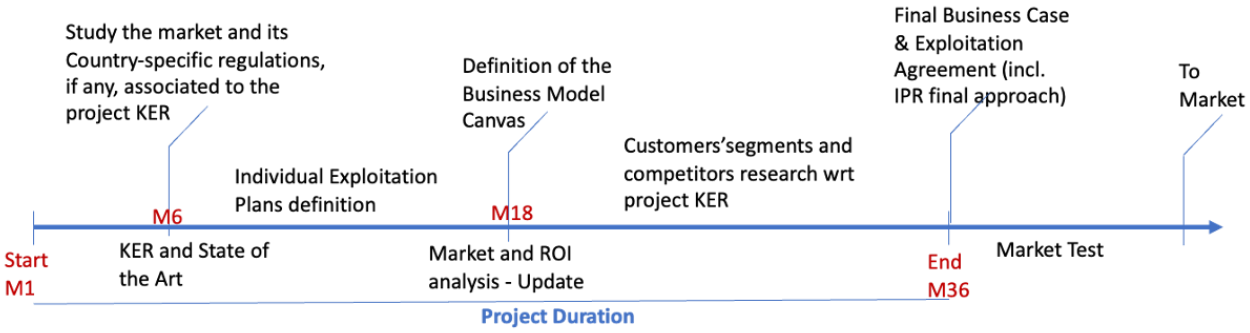

Figure 11 - Market Analysis roadmap

After the development of preliminary state of the art and redefinition of the Key Exploitable Results (KERs) delivered by M6, an understanding of the serviceable market (Addressable and Obtainable shares) will be part of the activities that will be carried out as subsequent tasks, in order to instantiate a Market Analysis for the agreed subset of KER that could be closer to entering the market at the end of the project. Evaluating all the KERs, a Business Model Canvas will be defined with each partner, to give a deeper overview of the business model associated to the identified market segments.

A template for the Market Analysis has been developed as a starting point to highlight the needed areas of the analysis to be executed by M18. Such document is thought of as a living document as it will need to be populated with the required information and updated during the project's implementation, following the evolution of the technical activities carried out in HARTU moving towards the development and enhancement of the KERs.

The Market Analysis will be revised in the last phase of the project, with specific focus on the maturity level of the proposed solutions and their value proposition, based on the analysis of the potential customers and competitors and on the costs and activities required to reach the commercialisation stage. The results will be implemented as part of the Business Case description.

For the KERs expected to require further development after the project lifecycle, the necessary steps towards the market will be identified in the last phase of the project in order to finalise the Business Case and define the Exploitation Agreement amongst the Consortium Partners (including the IPR final approach to be put in place).

5.2. Preliminary draft of the Market Analysis' structure

The Market Analysis is a living part of the document, meaning that it will be revised through several iterations. At the early stage of the Market Analysis, it is important to address the exploitable elements of the solutions that will be analysed and incrementally completed during the project lifetime. The resulting exploitable items that will reach a higher maturity level will allow a better assessment of their market opportunities, positioning, and defining the advantages of HARTU's

solutions compared to its competitors. In the following the different elements to be considered when carrying out the analysis between M6 and M18 are outlined and briefly described.

5.2.1 Key Exploitable Results (KERs)

Reviewing the Key Exploitable Results (from the proposal) helps identifying the project solution that might be brought to market. In the initial phase of the exploitation plan (M1-M6) a revised version of the KER was drafted (see the table in sub-section 5.2). The KERs items will be iterated several times throughout the project.

5.2.2. SWOT Analysis (Strengths - Weaknesses, Opportunities - Threats)

This method can be done on the overall solution or for each KER - it needs to be revised at the next iterations when the elements of the analysis provide more insights on the customer problem/need, on the market opportunities, and on the competitor product/services/solutions.

5.2.3. Customers

The identified Customer Segment is the Manufacturing company's segment. An analysis of the potential Customers for each KER of the project should be included here with the contribution of the industrial partners already addressing a share of the same market and having contacts with (or knowing) customers or prospects in the identified segment.

5.2.4. Market size and Trends

Once the revision of the KERs is performed, for each of them (or for a cluster of those that are in the same market) the analysis should include a revision of the market size and of its expected growth (i.e. CAGR%) which can be conducted with the support of the industrial partners having already market data available or through an Internet research.

5.2.5. Potential Markets

After the collection of initial data, this paragraph presents how the market is segmented, and which are the most promising market components in terms of potential customers. Typically, a description and a graphic representation will be included here. It also includes the size of reachable market, how many products and/or licenses we plan to sell to whom and at which price. A sales 5 years forecast would be added at a later stage.

5.2.6. Customer Perceptions of the KER

As part of the Market Analysis, it would be interesting to plan, at a certain stage of development within the project timeline, a customers' survey activity to verify that the KERs are: needed, which customer problem they help to solve or solve, if there are similar assets already used, what is the Value Proposition for each of them.

5.2.7. Product/s Distribution and Sales

Describe, at a second stage, how do we intend to reach the market (plan some actions to reach it).

Types of sales include: How do we plan to reach the customers?

5.2.8. Competition

Describe and list the identified competitors for each KER and/or for the HARTU solution.

Competition categories: List the categories of competitors (e.g. large companies, small independent consultancy firms,…)

Some key differences of our product include: list the main differences identified comparing the KER/Solution with the competitors' one.

5.2.9. Competitive advantage and analysis

Include a table comparing, on defined characteristics, the direct competitors with the project partners. Some of them are already known by the partners. It would be important not to be generic but to compare on the identified properties the HARTU KER/Solution to similar solutions already on the market, if any.

5.2.10. Market opportunities

What are the leading factors driving the demand (also based on the evaluation of the customer perception and on the trends in the market) and how the partners can exploit them.

5.2.11. Market Risks and Challenges

List the identified risks and challenges (related to for example: competition, economic changes, industry/customers needs changes) highlighting the related mitigations/actions

5.3 Updated Key Exploitable Results (KERs)

Each partner reviewed the Initial Key Exploitable Results from the proposal. This task helped us in better identifying the project's solutions that might be brought to market in the future. The following table provides the description of the KERs as well as a preliminary description of how the partners envision, at the present stage, the Intellectual Property Rights identified to exploit the different items. The table will be kept as a living artefact, revised several times throughout the advancements of the project. Each KER's item in the table was preliminary described by the partners as well as how they envision the associated Intellectual Property Rights. The TRL indicated in the table indicates the TRL that each item is supposed to reach by the end of the project to be exploited. The initial TRL of each KER item is mainly 4.

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Table 11 - Updated list of HARTU's KERs

Key Exploitable Result	Description of the KER items	Main partners	TRL	IPR	Description of the IPR	Market/Target group
R1: Tool to generate a dataset of labelled virtual scenes of workpieces	It takes as input the CAD model of a workpiece and generates virtual scenes of similar randomly arranged labelled objects, applying customer-defined domain randomization	TEK	6	Open Access/ License (TBD)	It will be analysed the IPR mechanism to apply, i.e. a permissive license (e.g., BSD-3) or a more restrictive commercial licensing.	System integrators and Deep Learning application developers
R2: Dataset of labelled objects	The datasets generated with R1 and other tools	TEK	8	Open Access	The dataset will be made open access via a relevant data repository, e.g., Zenodo.	System integrators and Deep Learning application developers

R3: Object segmentation module	DL model trained with the dataset of objects (R2). Image or 3D point cloud data set generated during the perception technology development.	TEK, AIMEN	6	Open Access	Permissive license (e.g., BSD-3) and shared via github.com to maximize its impact in the robotics community.	System integrators and Deep Learning application developers
R4: Grasp planner and execution pipeline	A software module that takes as input the CAD of a workpiece and a real scene with multiple instances of it and proposes the best candidate grasping point.	TEK	6	License	Initially, it will be included as an option of the SMART PICIKING software that TEK commercialises	Automation industry
R5: HARTU-APP-BUILDER, visual tool for application creation	Graphical tool to create an executable workflow for implementing a robotic manipulation application	TEK, ENG	6	Open Access	Permissive license (e.g., BSD-3) and shared via github.com to maximize its impact in the robotics community.	Automation, research groups in robotics

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R6: Robotic System/Cell for assembly	Robotic cell controller assembly task	ITRI	6	Agreement	Organizations interested in this Robot Cell Controller shall discuss the licensing details and terms with ITRI.	Robotic and automation system integrators for manufacturing companies with assembly processes
R7: Electroactive fingertips	Electroactive skins for robotic grippers with embedded sensors and electro-active fingertips that offer multiple functionalities, including electrically tuneable friction and adhesion. These robotic skins will be applied on robotic grippers to enhance their grasping abilities, for example enabling the grasping of delicate objects, or of objects that are currently difficult to grasp because flexible and thin.	POLIBA, OMNI	6	License	The technology will be made available to HARTU. We will utilize an IPR mechanism to determine the applicable licensing approach, which could range from a permissive license to a more restrictive commercial license.	Automation industry
R8: Dataset of grasping	Software that produces a successful grasping posture for	OMNI	6	Agreement	Organizations interested in these software controllers shall discuss	Automation industry

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control strategies	a set of objects connected with the project use-cases.				the licensing details and terms with OMNI.	
R9: Adaptive Platform for Robotics Orchestration (APRO)	A novel RA through which to ensure compliance with standards, foster OSS adoption and guide the integration of handling application components, simulation and perception capabilities, as well as of legacy systems and shopfloor devices.	ENG, AIMEN, TEK, DFKI, ITRI	6	Open Access	Once the APRO platform features and building blocks are defined, the developing partners will discuss to reach an agreement on the most suitable OSS licensing framework.	System integrators and application builders

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R10: Learning-from-demonstration framework for contact interaction tasks	Software framework for learning assembly skills from demonstrations. Fort research purposes the goal is to push forward the topic of learning contact-rich robotic manipulation tasks. Regarding industrial automation, the framework may increase flexibility of assembly lines, and reduce time for reconfiguration.	DFKI	6	Open Access	The framework is offered as open-source software with permissive license (e.g., BSD-3) and will be shared via github.com to maximize its impact in the robotics community and benefit from the contributions of others. The visibility of the software will be increased through scientific publications, e.g., at relevant robotics conferences. In the long run, it can serve as a basis for further research in later projects and be used by companies in industrial manufacturing. In the latter case, DFKI could offer system integration and application setup as a service.	Scientific Community, System integrators for industrial automation

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R11: Contact wrench classifier	Software for classification of contact forces, which can distinguish “normal” from “undesired” situations during assembly.	DFKI, ITRI	6	Open Access	The framework is offered as open-source software with permissive license (e.g., BSD-3) and will be shared via github.com to maximize its impact in the robotics community and benefit from the contributions of others. The visibility of the software will be increased through scientific publications, e.g., at relevant robotics conferences. It may serve as basis for further research in future publicly funded projects.	Scientific Community

R12: Assembly dataset	Dataset containing robotic sensor data recorded during various assembly operations, both in laboratory and in industrial environments. Such data sets are an important means for reproducing research and can be used by others to foster scientific knowledge gain. Also, system integrators might take the data into account when setting up industrial assembly applications.	DFKI, ITRI	6	Open Access	The dataset will be made open access via a relevant data repository, e.g., Zenodo. It will be accompanied with a scientific publication.	Scientific Community, System Integrators
R13: Demonstrators in 5 manufacturing and logistic scenarios	ULMA: In the logistic sector, there will be available a new product to offer for multi-reference order picking. TCA: The technology will be demonstrated in industrial environment. In the agrifood sector, the demonstrator of automated robot capable of intelligent handling of a variety of different products with high vision and precision in terms of shape and size	ALL	6	Open Access		Industrial manufacturing or distribution companies

	could be a disruptive technology challenge for all the sectors, to be implemented in different processes					
R14: Tactile sensors based-on FBGs	Tactile sensors based on the fibre brag grating technology for continuous monitoring of the contact forces between objects and grippers	AIMEN	5/6	License	The technology will be available for HARTU grippers (subjected to the feasibility). We will analyse the IPR mechanism beyond the HARTU official timeline, i.e., a permissive license (e.g., BSD-3) or a more restrictive commercial licensing.	Robot manufacturers and System integrators
R15: Object identification using meta-learning and frugal-AI.	AIMEN will implement the object identification and pose estimation-based tool chain using the state-of-the-art meta learning and frugal-AI based methods.	AIMEN	6	License	The technology will be available for HARTU. We will decide the IPR mechanism to apply, i.e., a permissive license (e.g., BSD-3) or a more restrictive commercial licensing.	System integrators and application builders

R16: Human-centric design guidance for the integration of AI-Robotics in manufacturing lines, and Skills transformation map	Using a human-centric design approach DBL will be able to provide, as a service, specific guidance to manufacturing and logistic lines that are considering and/or are about to implement Robotics and AI in their production processes. The service provides support in ensuring that Human Factors, as well as other Social and Societal aspects (e.g., ethics, liability, user- acceptance/ experience/trust, training), are considered during the design, implementation, validation of the innovative technologies for the manufacturing industries. The service could be articulated into different sub-services to be applied depending on the end-user's needs.	DBL	N/A	Agreement	Consultancy Service Offer	Industrial manufacturing companies, Automation industry

During the mid-phase of the exploitation path (M6-M18), an individual Exploitation Plan will be formulated together with each partner using a Business Model Canvas method.

5.4. Preliminary State-of-the-art on market trends in the manufacturing industry

The manufacturing industry is undergoing a considerable change as novel technologies such as artificial intelligence (AI), robots, and collaborative robots (cobots) become prevalent. These technologies have the capacity to transform multiple aspects of the manufacturing sector: production processes, quality control processes, and the overall operational efficiency.

This Section aims to provide insights into the current trends and market share of AI, robotics and co-bots, in the manufacturing sector to provide a preliminary state of the art.

5.4.1. AI Market

The smart enterprise trend, powered by AI and focused on data analysis and insights, is leading businesses in manufacturing and management. This trend is anticipated to boost productivity across major sectors, with manufacturing being the fastest-growing sector as digital transformation accelerates. According to industry projections published by Deloitte (2020), by 2030, AI will find its largest markets in manufacturing (16%), communication, media, and services (16%), and natural resources and materials (14%). Manufacturing, in particular, is embracing digital transformation to promote smart solutions in management, industrial operations, and logistics.

China, the United States (US), and the European Union (EU) are the key players in AI development in the manufacturing sector. The global market for AI in manufacturing was worth approximately EUR 2.7 billion in 2021 and is expected to reach EUR 71.9 billion by 2030 (Acumen Research and Consulting, 2022). In Europe, the market for artificial intelligence in manufacturing is predicted to develop at a 42.9% CAGR from 2022 to 2028 (Research and Markets, 2022).

Manufacturing processes generate vast amounts of data, including production, quality control, and management information. With the advent of sensors and other data-capturing technologies, factories may produce millions of entries every day, resulting in approximately 1,812 petabytes (PB) of data annually, which is far more than that of communications and media (776 PB), banking (773 PB), and retail (424 PB) (Deloitte, 2020). To make sense of this massive volume of data, manufacturers are increasingly turning to AI and smart technologies. These technologies enable efficient data processing, uncover data patterns, and address problems that were previously difficult to anticipate.

Manufacturers encounter several challenges in production and operations according to surveys, the most significant of which are rising costs (29%), lack of agility in production line design (25%), and unstable quality and yield (18%) (Deloitte, 2020). AI can address these challenges by automating processes, improving operational efficiency, lowering costs, forecasting market trends, optimizing production schedules, and enhancing quality inspection and product yield.

5.4.2. Robotics Market

The field of robotics incorporates a wide range of products that can be categorized into four main groups: traditional industrial robots and collaborative robots (cobots), fixed professional services

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including medical and agricultural applications), mobile professional services (such as cleaning, construction, and underwater tasks), and automated guided vehicles (AGVs) used for transporting items of varying sizes in logistics or assembly lines (Lässig et al., 2021).

The global robotics market is expected to witness significant growth, with projections indicating a climb from about EUR 22 billion in 2021 to an estimated range of EUR 146 to 237 billion by 2030. Among these categories, professional services robots are expected to have a market share of up to EUR 155 billion, while industrial and logistics robot sales are estimated to reach approximately EUR 73 billion (Lässig et al., 2021).

5.4.3. AI-powered Robots Market

The convergence of robotics and Artificial Intelligence (AI) is rapidly emerging as a prominent catalyst for the emergence of novel industries, state-of-the-art technologies, and enhanced productivity and efficiency across established sectors. AI plays a crucial role in enabling robots to acquire specialized skills by leveraging a range of sensors, such as time-of-flight optical sensors, temperature and humidity sensors, ultrasonic sensors, vibration sensors, and millimeter-wave sensors. By utilizing these sensors, robots are able to acquire knowledge and adjust their behavior, resulting in enhanced intelligence and improved ability to respond effectively in diverse situations (University of San Diego, n.d.).

The global market size of AI robots is expected to reach around EUR 49.5 billion by 2030, with a compound annual growth rate (CAGR) of 21.81% from 2022 to 2030. In 2021, North America held a market share of 32.5%, while Asia Pacific and Europe accounted for 28% and 24.5% of the market, respectively (Precedence Research, 2022). The industrial robot type segment dominated the market in 2021, with a 61.35% global market share, driven by improved productivity due to analytical maintenance (Precedence Research, 2022).

A collaborative robot (i.e., cobot) is specifically designed to facilitate direct collaboration or physical contact between humans and robots within a shared workspace or when they are in close proximity. Unlike traditional industrial robots that are typically kept separate from people, cobots are intended for applications that involve human interaction. They can be employed for a wide range of tasks, including serving as communication robots in public spaces, handling material movement in logistics or supply chain operations within a facility, or functioning as articulated or industrial robots to automate tasks that are physically demanding and may pose ergonomic challenges, for example, carrying large components or contributing to assembly line processes (Borboni et al., 2023).

The cobots market is also poised for substantial growth in the coming years. In 2022, its value was estimated to be approximately EUR 0.7 billion and is anticipated to reach EUR 20.6 billion by 2032, reflecting an impressive CAGR of 40.5%. By the year 2025, collaborative robots are expected to account for roughly 10% of the overall industrial robot sales (Mellisa, 2023). In terms of market share, Europe currently holds the leading position in the collaborative robot market, with a valuation of around EUR 0.3 billion in 2022. However, North America is expected to surpass Europe by 2032, driven by a slightly higher CAGR of 39.5% and reaching a market value of EUR 6.6 billion. Meanwhile,

the cobots market in the Asia Pacific region is experiencing the highest CAGR of 47.3% (Mellisa, 2023).

Cobots find applications in various sectors, including material handling, assembly, welding and gluing, dispensing, pick & place, quality testing, machine tending, and others. The assembly segment is the highest contributor to the cobots market, with a 40% market share in 2022. It is projected to reach EUR 8 billion by 2032, driven by the automotive, metal and machinery, and electronics industries (Mellisa, 2023). The pick and place segment holds a 20% market share, followed by handling (13%) and packaging (11%). Machine tending and quality testing segments are also expected to grow significantly, with projected CAGRs of approximately 42-43% (Mellisa, 2023).

Cobots are utilized in various segments, such as material handling, assembly, welding and gluing, dispensing, pick & place, quality testing, machine tending, and others. Among these, the assembly segment plays a pivotal role in the cobot market, accounting for a market share of EUR 0.27 billion in 2022, which represents 40% of the market. It is expected to achieve a market value of EUR 8 billion by 2032, driven primarily by the automotive, metal and machinery, and electronics industries (Mellisa, 2023). The second position belongs to the pick and place segment with a 20% market share in 2022, while handling and packaging segments held 13% and 11% shares, respectively. Furthermore, the machine tending and quality testing segments represented 5% and 7% of the market sequentially, and are anticipated to undergo substantial growth, exhibiting compound annual growth rates of approximately 42-43% (Mellisa, 2023).

The end-users of cobots include the automotive, furniture and equipment, metal and machinery, food and beverage, and electronics industries. Automotive and furniture and equipment industries hold the largest shares of the market (24% and 20%, respectively). Other significant end-users include the metal and machinery sector (16%), food and beverage industry (13%), and electronics sector (12%) (Mellisa, 2023).

In conclusion, AI, robots, and cobots are revolutionizing the manufacturing sector. AI is expected to play a pivotal role in addressing manufacturing challenges, optimizing operations, and improving overall productivity. The global market for AI robots and cobots is growing rapidly, with North America, Europe, and Asia Pacific as key players. The collaborative robot market is particularly promising, with significant growth expected across various applications and industries. As manufacturers continue to embrace these technologies, the future of the manufacturing sector looks increasingly automated, efficient, and intelligent.

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6. Stakeholders' engagement

6.1 Overview

6.1.1. Goals

The purpose of these activities is to organize a structured dialogue between the project and several European stakeholders, either from public or private entities, in order to maximize HARTU's outreach. It includes clustering and cross-fertilization activities with other EU funded projects, such as sister projects funded under the same topic and other relevant international projects and initiatives within the field, dissemination activities and exchange of best practices and challenges and increase the uptake potential of HARTU across Europe and beyond (i.e., EU-Taiwan Robotics Working Group).

An additional objective is to contribute to standardisation activities, in particular with standardisation bodies working on benchmarking for handling tasks.

6.1.2 Target Audience

Initially HARTU considers the following stakeholders as the most relevant to engage with:

- Industrial manufacturing companies in different sectors;
- System integrators and application builders;
- Robot manufacturers and Automation industry;
- Decision and Policy Makers: European Commission, Industrial associations, Stakeholder communities and networks, such as the Made in Europe partnership, the Industry4Europe coalition, national manufacturer associations, Food industrial associations, etc.
- Standardisation bodies;
- Scientific and Academic Community;
- Workers and Managers working in the manufacturing sector;
- Other projects working in the field, in particular the 3 sister projects funded in the same topic;
- Interested general public.

6.1.3. Approach

Besides the communication and dissemination activities focused on those groups, HARTU consortium is committed to collaborating with other stakeholders to boost the robotics industry in Europe. This collaboration is underpinned by four initiatives:

- An AB will be created to receive feedback from relevant external experts
- Collaboration with the more relevant DIHs and National initiatives
- Collaboration with ongoing projects and platforms, such as the AIOD Platform, the first European AI On-Demand Platform with shared resources, tools, knowledge, and algorithms

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- Collaboration with standardization bodies working on benchmarking mechanisms for handling tasks

6.2. Stakeholders' engagement actions

6.2.1. Ongoing projects in the same topic

From the very beginning of the project, HARTU has promoted the collaboration with the 3 sister projects that are running under the topic HORIZON-CL4-2022-TWIN-TRANSITION-01-04. To achieve this objective, we have been supported by the Project Officer Giovanni Emma, who has put the four project coordinators in contact with each other.

The other three projects funded in the topic are:

- **SMARTHANDLE. Resilient manufacturing lines based on smart handling systems.** Coordinator: Arantxa Renteria (TECNALIA)
- **MASTERLY. Nimble Artificial Intelligence driven robotic solutions for efficient and self-determined handling and assembly operations.** Coordinator: Dimosthenis Dimosthenopoulos (LMS)
- **AGILEHAND. Smart grading, handling, and packaging solutions for soft and deformable products in agile and reconfigurable lines.** Coordinator: Filippo E. Ciarapica (UNIVERSITA' POLITECNICA DELLE MARCHE – UPM)

As a first step, an audio conference was held on 6th February, in which the four projects presented an overview and some initial collaboration activities were proposed:

- **Dissemination activities:**
  - The four projects were invited and participated in the "10th WORKSHOP ON HYBRID PRODUCTION SYSTEMS" in the context of the European Robotics Forum [8] held in Odense on 15th March 2023. The workshop was chaired by LMS
  - Include cross-references on the websites of the four projects
  - Reposting of social media posts
  - Possible collaboration in the organization of future workshops
  - Possible common white paper at the end of the projects
- **Technical collaboration:**
  - Benchmarking opportunities: to define common procedures or experimentation setups for some of the common problems we are addressing
  - Share datasets
  - To create a common 'taxonomy' to characterize and define the parts, in terms of handling
  - To exchange technical information in several topics
  - To collaborate on SSH related aspects, such as:

[8] https://erf2023.sdu.dk/program/

        - Surveys/questionnaires: to share some common questions, in order to obtain statistically more relevant results (broader spectrum of end-users)
        - Operator skills. HARTU and SMARTHANDLE will address the operators' skills. The leading partners can exchange information/experiences.
        - Ask system integrators to share their vision (in HARTU and SMARTHANDLE the partners playing this role are both from the Netherlands, which can facilitate the communication)
    - Standardization efforts. Try to identify common interests in those projects that have planned activities related to standardization, e.g., HARTU would like to contribute to groups working in benchmarking.
    - International cooperation. As there are partners from Taiwan (HARTU), Japan (AGILEHAND) and South Korea (MASTERLY), as well as one participant that belongs to a Japanese company (SMARTHANDLE), it will be asked them to identify mechanisms for collaboration at the Asian level
    - To exchange information on similar type of applications: Logistics, Assembly, Machine Tending, etc.
- **Others:**
    - External Advisory Boards. If the figure of EAB is included in several projects, try to include some common people that can have a common vision of what is being done in the projects to facilitate the identification of possible collaboration.

The group has planned to meet regularly, every 6 months to exchange experiences and decide further actions.

Further collaborative activities will be explored with other ongoing projects involving members of the HARTU Consortium, such as MERGING (AIMEN) and APRIL (DFKI) on flexible materials handling.

6.1.2. DIHs and National initiatives

Partners of HARTU are members of several Digital Innovation Hubs, initiatives and associations. Through this participation, collaboration in co-organising events, workshops, open days, etc. will be explored.

Some of these initiatives and the partners involved (between brackets), are the following:

- DIH2 (TEK), TRINITY, BDIH (TEK), euRobotics (TEK, AIMEN and DFKI), Cyprus Digital Innovation Hub and DIH Agrifood Croatia (TCA is in contact and both work on robotics); DIH4INDUSTRY (ENG), Digital Innovation Hub Noord-Nederland (PCL and FMI)
- Data Space Business Alliance (ENG is core partner in all the four founding Associations), Digital Factory Alliance (ENG is among the founding member)
- 5R, Spanish Network of excellence in robotics technologies in manufacturing (TEK and AIMEN), HISPAROB: Spanish robotic platform (TEK), AER: Spanish association of Automation and Robotics (TEK)
- Taiwan Automation Intelligence and Robotics Association (TAIROA)

6.1.3. Advisory board

The advisory board will be setup before M12. The composition of the advisory board will be decided among the experts proposed by the consortium. A tentative composition could be:

- **Robot manufacturer:**
  - Any representative of the most relevant robotic companies: KUKA, ABB, STAUBLI, UR, COMAU, etc.
- **Industrial Gripper builder:**
  - Any of the big players: Schunk, OnRobot, SMC, etc.
  - A custom gripper builder: Canonical Robots, SVERITAL, etc.
- **Relevant scientist in the field of robot handling:**
  - Initially, Prof. Dario Floreano will be invited. If his collaboration is not possible, other alternatives will be explored.
- **A representative of an Industrial association:**
  - Food sector
  - Manufacturing (EFFRA, MANUKET, etc.)
  - Logistic sector
- **Elena Messina from NIST**

6.1.4. Standardization

The most relevant standardisation activities related to HARTU's objectives will be identified and analysed. Initially in the field of benchmarking of handling operations:

- The National Institute of Standards and Technology (USA) is developing an assessment framework for robot systems within manufacturing assembly)
- ISO/TC 299 Technical committee on Robotics, which includes two working groups “ISO/TC 299/WG 8 Validation methods for collaborative applications” and “ISO/TC 299/WG 4 Service robot performance”

After these first activities, how to contribute to the next steps will be explored.

Bibliography

Acumen Research and Consulting. (2022, July). Artificial Intelligence in Manufacturing Market Analysis. Retrieved June 22, 2023, from https://www.acumenresearchandconsulting.com/artificial-intelligence-in-manufacturing-market

Borboni, A., Reddy, K. V. V., Elamvazuthi, I., AL-Quraishi, M. S., Natarajan, E., & Azhar Ali, S. S. (2023). The Expanding Role of Artificial Intelligence in Collaborative Robots for Industrial Applications: A Systematic Review of Recent Works. Machines, 11(1), 111. Retrieved from https://www.mdpi.com/2075-1702/11/1/111

Deloitte. (2020). AI enablement on the way to smart Manufacturing. Deloitte China. https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/cip/deloitte-cn-cip-ai-manufacturing-application-survey-en-200116.pdf

Lässig, R., Lorenz, M., Sissimatos, E., Wicker, I., & Buchner, T. (2021, June 28). Robotics Outlook 2030: How Intelligence and Mobility Will Shape the Future. BCG. Retrieved June 22, 2023, from https://www.bcg.com/publications/2021/how-intelligence-and-mobility-will-shape-the-future-of-the-robotics-industry

Melissa, R. (2023, May 2). Collaborative Robot Market is Charging at 40% CAGR. Statzon. Retrieved June 22, 2023, from https://statzon.com/insights/global-collaborative-robot-market

Precedence Research. (2022, August). Artificial Intelligence (AI) Robots Market Size. Retrieved June 22, 2023, from https://www.precedenceresearch.com/artificial-intelligence-robots-market

Research and Markets. (2022, May). Europe Artificial Intelligence in Manufacturing Market . Retrieved June 22, 2023, from https://www.researchandmarkets.com/reports/5615721/europe-artificial-intelligence-in-manufacturing

University of San Diego. (n.d.). Introduction to AI Applications in Robotics. Retrieved June 22, 2023, from https://onlinedegrees.sandiego.edu/application-of-ai-in-robotics/