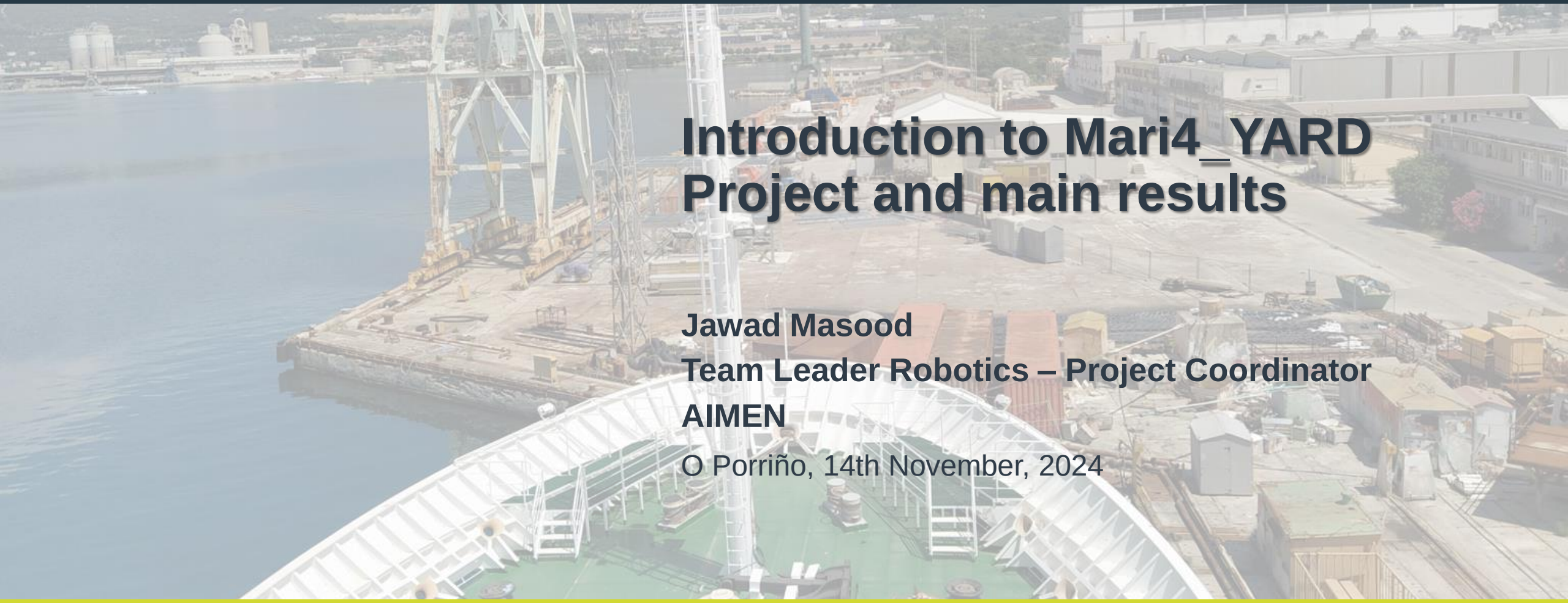
User-centric solutions for a flexible and modular manufacturing in small and medium-sized shipyard

MARI4YARD



Introduction to Mari4_YARD Project and main results

Jawad Masood
Team Leader Robotics – Project Coordinator
AIMEN

O Porriño, 14th November, 2024

4th Workshop - AIMEN Technology Center, Spain

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101006798

Context of Mari4_YARD @Workshop 4

The main objectives of todays event

- **To get together and discuss the main challenges**
  - Future of shipbuilding
- **To present the project results to main stakeholders**
  - Mari4_YARD human centric technologies such as
    - Digital Solutions for 3D Modeling: These solutions will streamline the retrofitting and repairing of vessels, reducing rework and changes by up to 60%.
    - Safe Robot-Based Solutions: Collaborative robots will be integrated into the shipyard environment to improve efficiency and reduce process time.
    - AR/MR Tools: Augmented and mixed reality tools will assist workers in positioning equipment and subassemblies with greater precision.
    - AI-Enhanced Exoskeletons: Exoskeletons powered by AI will reduce worker fatigue and improve task quality and precision.
- **How to protect our knowledge, IP protect.**
- **Explore future opportunities and challenges**
  - Roundtable – Q&A
- **Networking and information exchange around Europe and beyond**

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Objectives and concept

Portfolio of worker-centric tools that allows for an easy deployment of advanced technologies.

Scenarios

- Shipbuilding
- Retrofitting/Repairing

Impact areas

- Safety
- Quality
- Productivity

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Objectives and concept

Scope

- Increase the efficiency in the manufacturing of complex vessels by small and medium-sized shipyards
- Preserving industry-specific workers' knowledge

Approach

- Automation based on worker-centric tools
- Modular, portable and flexible equipment

Deployment

- New construction and retrofitting/repairing
- Steelwork, pre-production and outfitting stages

Worker-centric approach

User acceptance

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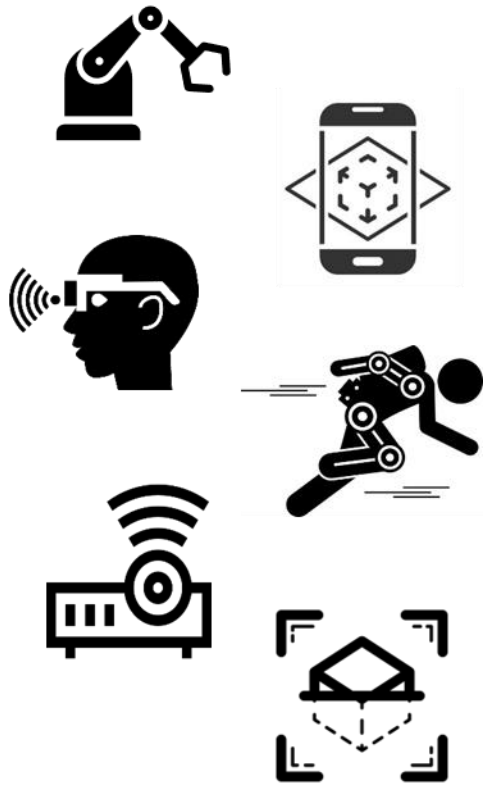
Mari4_YARD solutions portfolio

To implement a portfolio of worker-centric tools (TRL 7)



- High-payload collaborative robots for assisting operators and acting as work-holding devices
- Flexible and mobile manipulators (Easy to deploy)
- Upper-limb and lumbar exoskeletons
- Projectors and handheld devices providing instructions to operators in the manufacturing processes
- Head Mounted Displays for training
- Digitalization and reverse engineering (3D scanning)

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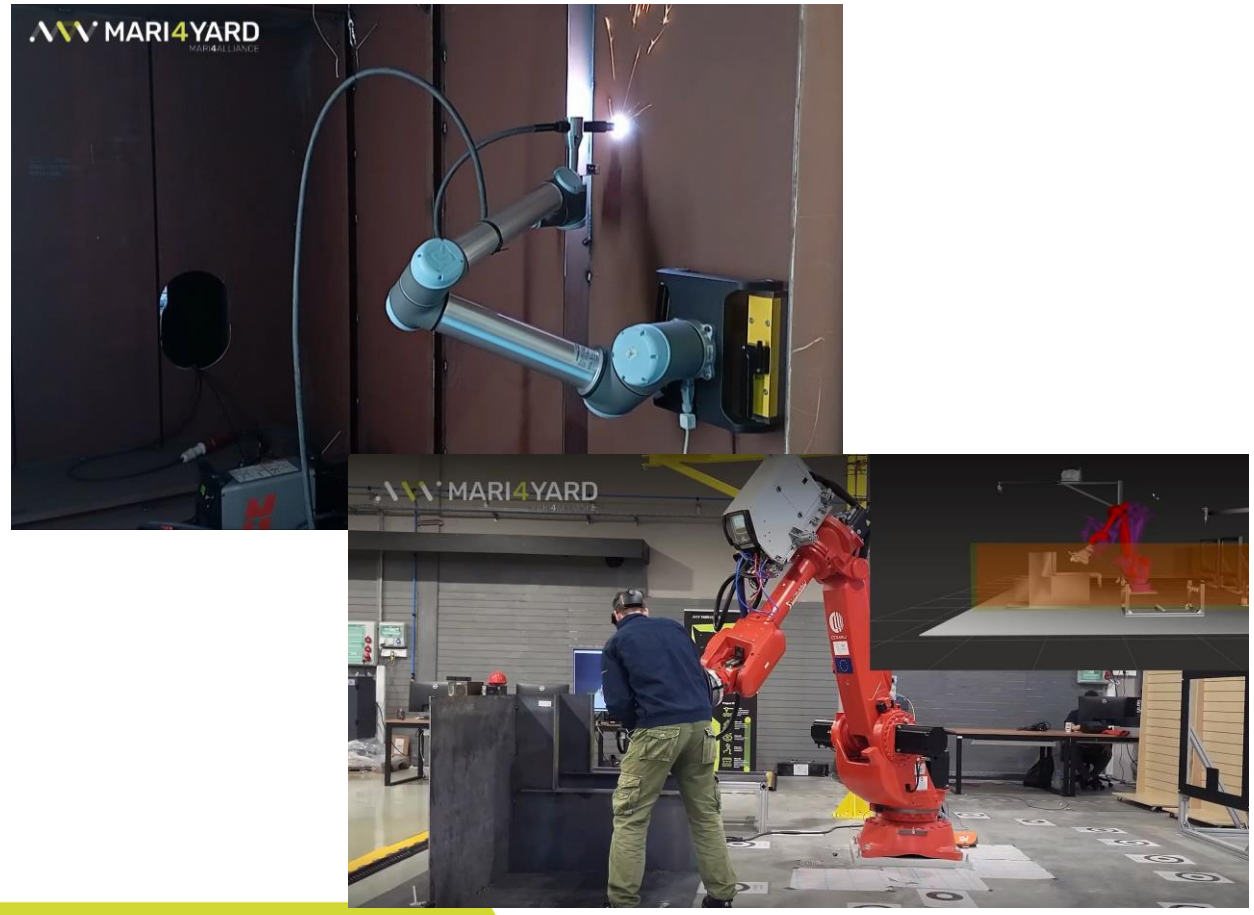
Mari4_YARD solution target

Development of intuitive human-robot collaborative solutions



- Symbiotically integration of operators' skills and dexterity into flexible and reconfigurable solutions
- Safe, modular and collaborative robot solutions
- Programming and setting time reduction by skill-based and intuitive robot programming
- Reduction of production process time

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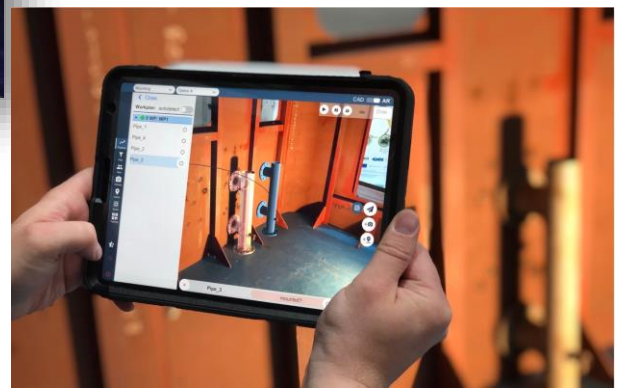
the European Union

Mari4_YARD solution target

To develop handheld and portable AR/MR tools for assisting shipyard workers



- Reducing reworks and changes, particularly in the latest phases of the construction
- Increasing precision and quality by relying on AR/MR tools for a precise positioning of the different subassemblies
- More efficiently training for new shipyard workforce in machinery and deck equipment

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Mari4_YARD solution target

AI-assisted exoskeletons for reducing fatigue and physical stress

- Reduction of workers physical effort in the execution of the target tasks
- Usability and acceptability assessed
- Improvement of the ergonomics risk factor in the target applications

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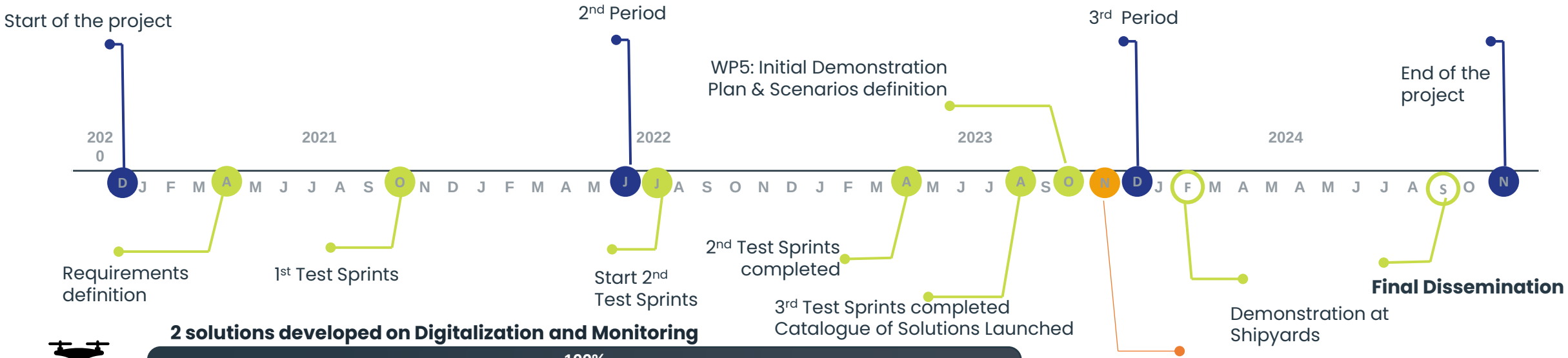
The Journey



2 solutions developed on Digitalization and Monitoring

100%

3 solutions developed on Robotics applications

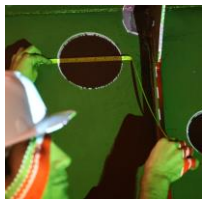
100%

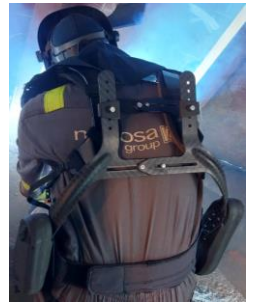
5 solutions developed on AR/MR tools

100%

2 solutions developed on Exoskeletons

100%





Demonstrations

100%

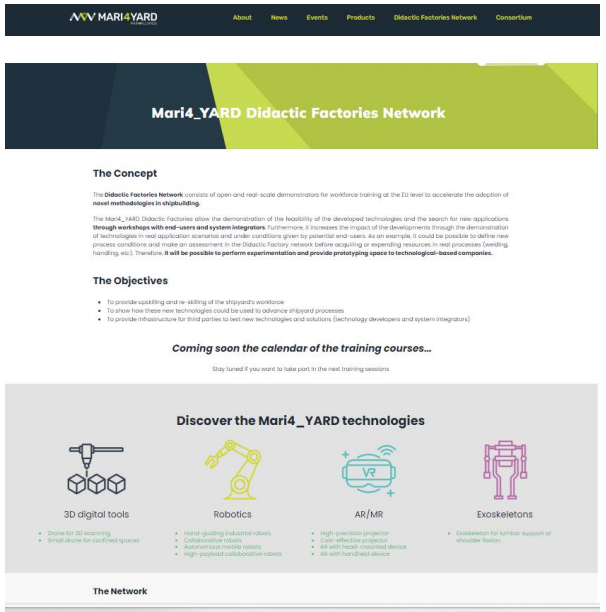
Funded by the European Union

General Impact of the project outcomes

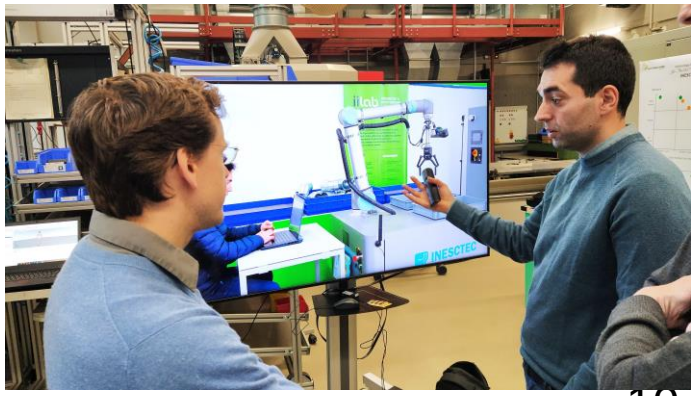
Technology transfer

Demonstrate Mari4_YARD approach at real-scale targeting both shipbuilding and retrofitting in SME-shipyards (TRL7), fostering results exploitation and enabling EU wide manufacturing adoption

- **2 real-scale demonstrators** (TRL 7) in small-sized (NODOSA) and medium-sized (BRODOSPLIT).
- **Didactic Factories Networks**: 5 open pilot lines, hosted at RTOs, enabling EU-wide workforce upskilling and technology adoption by EU industry, ensuring a successful market uptake
- **Mari4 alliance community**: engage stakeholders to participate in the community, promoting the Mari4_YARD and its results and opportunities.
- **Training courses**



https://www.mari4yard.eu/



Funded by the European Union

General Impact of the project outcomes

Dissemination and Outreach

followers **395**, Impressions **87363**, Visits **3205**

subscribers **13**, videos 14, views **1022**

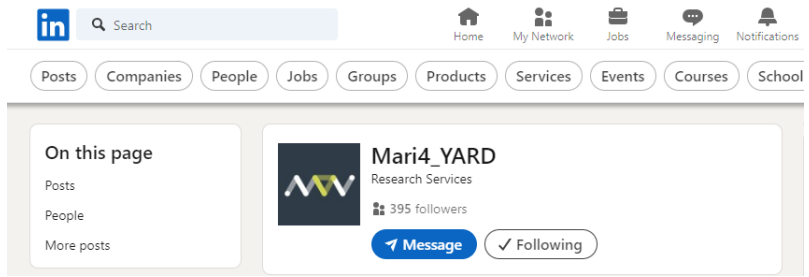
followers **60**, Impressions **8099**, Visits **8476**

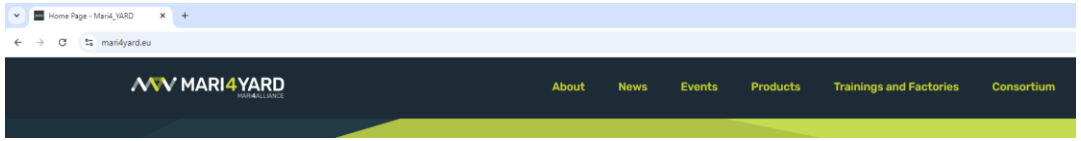
users **5070**, Views >**15000**

300 people

15

10





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General Impact of the project outcomes

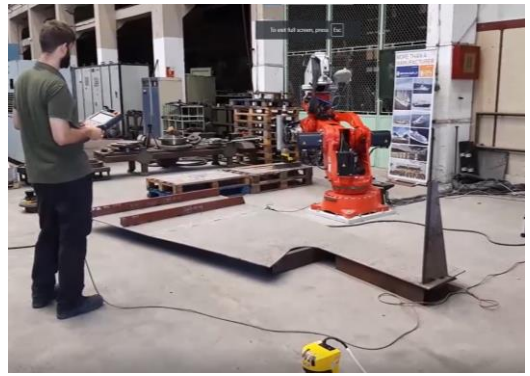
Brodosplit shipyard - 7 solution deployment

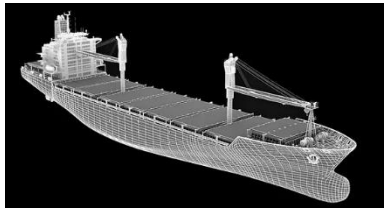
Worker-centric tools to be deployed

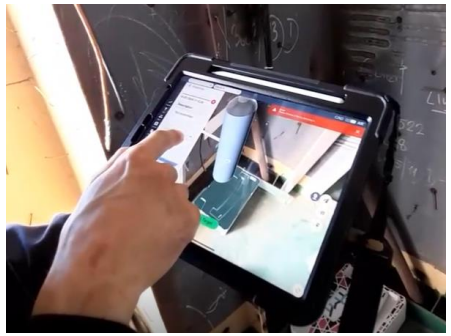
- Digitalisation using reverse engineering, 3D scanning and 3D modelling
  - **Production planning**
  - **Continuous monitoring**
  - **Pre-step for other digitalisation phases**

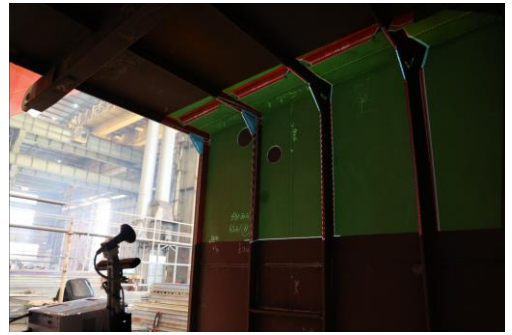
- Augmented and Mixed reality
  - **Construction supervision**
  - **Production planning**
  - **Workers training**

- Use of robots with fast programming
  - **Production improvement**
  - **Quality improvement**









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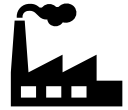
General Impact of the project outcomes (11 Use-cases and 33 KPI's) - BIS

C	Use-Case
Advance monitoring using 3D scanning	Scan the finished vessel
High-payload robots in shared space with humans	Robot to transport parts
	Help worker when supporting heavy part in position to be fixed
Augmented reality with handheld devices	Position elements by means of AR/VR based in the vessel 3D Model
	Identify elements by means of AR/VR
Mixed reality with headsets	Identify elements by means of AR/VR
	Help workers to install/check equipment using AR/VR
Mixed reality with AR glasses	Identify elements by means of AR/VR
	Help workers to install/check equipment using AR/VR
High precision projection system	Position elements by means of projection based in the vessel 3D Model
Cost effective projection	Position elements by means of projection based in the vessel 3D Model

Target KPI's

Productivity



- Time Saved
- Cycle Time Reduction
- Process Time Improvement
- Training Time Reduction
- Setup Time Reduction

Accuracy and Quality

- Error Reduction
- Accuracy Improvement
- Precision of Projections
- Collision Problems Avoided

Efficiency

- Robot Programming Time Reduction
- Ergonomics Improvement
- Hand Guiding Assistance Time
- Operation Time Improvement

User Adoption and Satisfaction

- User Satisfaction
- Acceptance Rate
- Knowledge Retention

Cost and Resource Savings

- Paper Drawings Reduced
- Rework Reduction
- Installation Time Savings

Training and Development

- Training Time Reduction
- Knowledge Retention
- Skill Improvement

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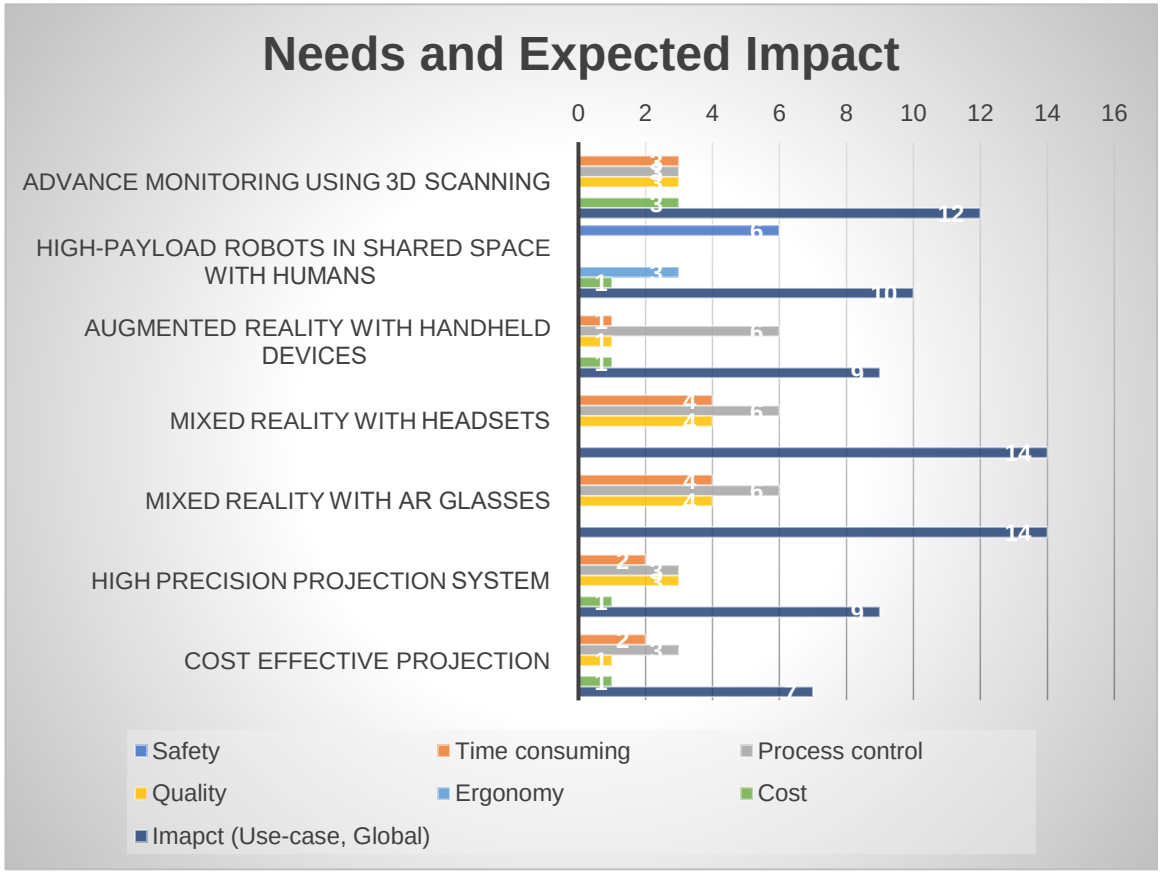
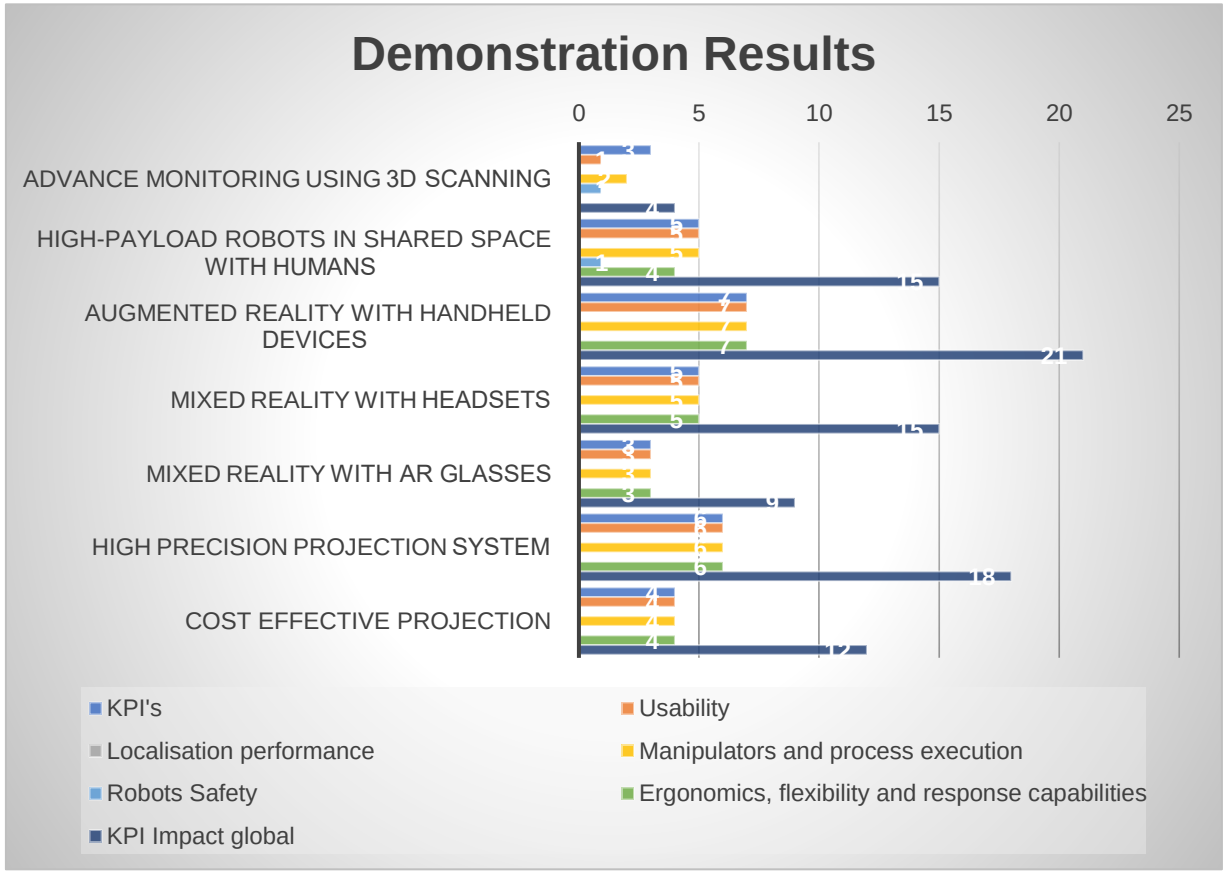
General Impact of the project outcomes





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General Impact of the project outcomes

We have prepared demos, where tech developers can give you handson :

Technologies	Location
Advance monitoring using 3D scanning	Hall
High-payload robots in shared space with humans	Video and demo on the workshop
Augmented reality with handheld devices	Hall
Mixed reality with headsets	Remote
Mixed reality with AR glasses	Hall
High precision projection system	Workshop
Cost effective projection	Workshop

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General Impact of the project outcomes

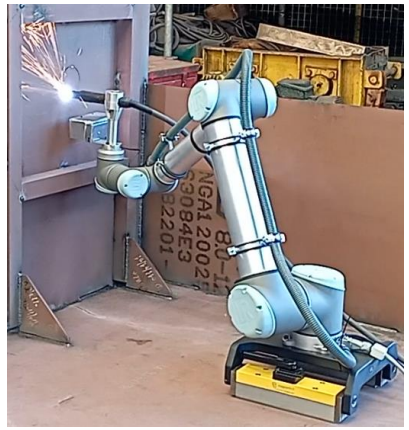
Nodosa shipyard - 5 solution deployment

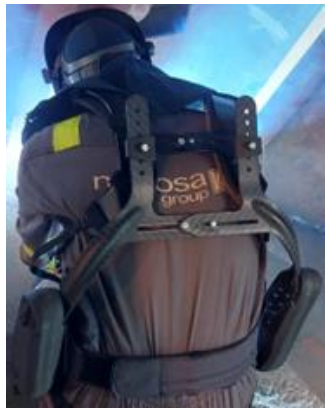
Worker-centric tools of main interest

- Exoskeletons for welding in non-ergonomic poses
- Use of small robots inside the vessels for welding operations
- Use of robots in shared space in the workshop (fast teaching)

Potential impact

- Improvement on working conditions ↑
- Reduction of welding time ↓
- Improvement on repeatability and quality of welding ↑





Funded by the European Union

General Impact of the project outcomes (9 Use-cases and 29 KPI's) - NODOSA

Technologies	Use-Case
Shipyard production planning based on aerial surveillance	Operational planning based on aerial survillance
Small drone for confined spaces	Remove gas from refined spaces using drone
Collaborative robots	Robot to cut openings
	Welding robots to weld pipes in the blocks.vessels
	Compare the real position of equipment and elements by 3D scanning
Mobile robots	Autonomous part placement/welding with mobile robots
	Help workers when supporting heavy part in position to be fixed
Exoskeletons for shoulder and trunk support	Help workers using exoskeletons
	Help workers when supporting heavy part in position to be fixed

Target KPI's

Data Import and Integration

- Time to Import Point Clouds
- Time to Import CAD Formats
- Number of Importable File Formats

System Performance

- System Setup and Deployment Time
- Time to Read Measured Parameters

Reliability and Uptime

- System Reliability and Uptime Rate
- Number of Completed Tasks

Deployment and Connection

- Hardware Deployment Time
- Electrical Component Connection Time

Accuracy and Precision

- Measurement Deviation from Real Values
- Accuracy of Robot Positioning

Task Efficiency and Productivity

- Time to Complete Welding Tasks
- Time to Complete Cutting Tasks
- Time to Pick Up Objects

User Experience and Ergonomics

- Exoskeleton Usability and Comfort
- Impact on Physical Effort and Fatigue
- Ergonomics Risk Index Reduction

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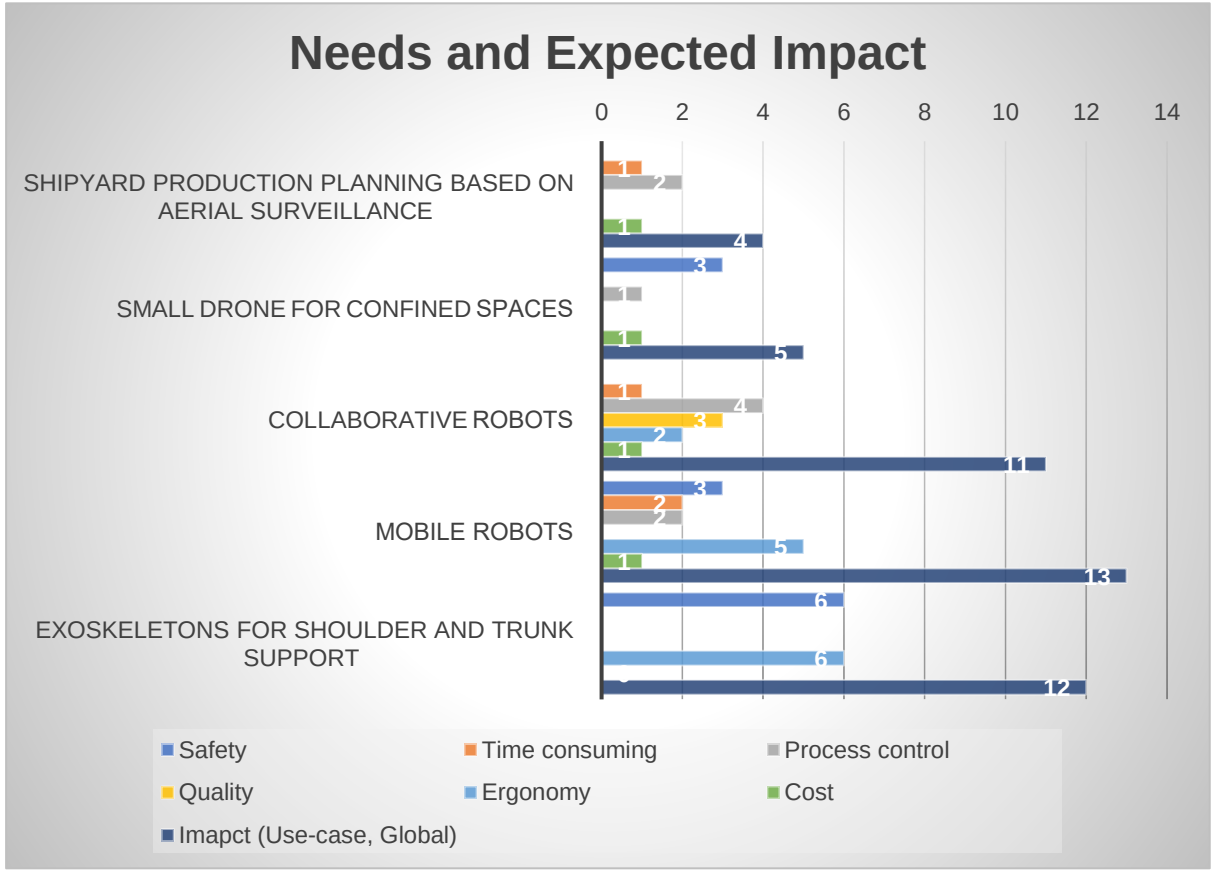
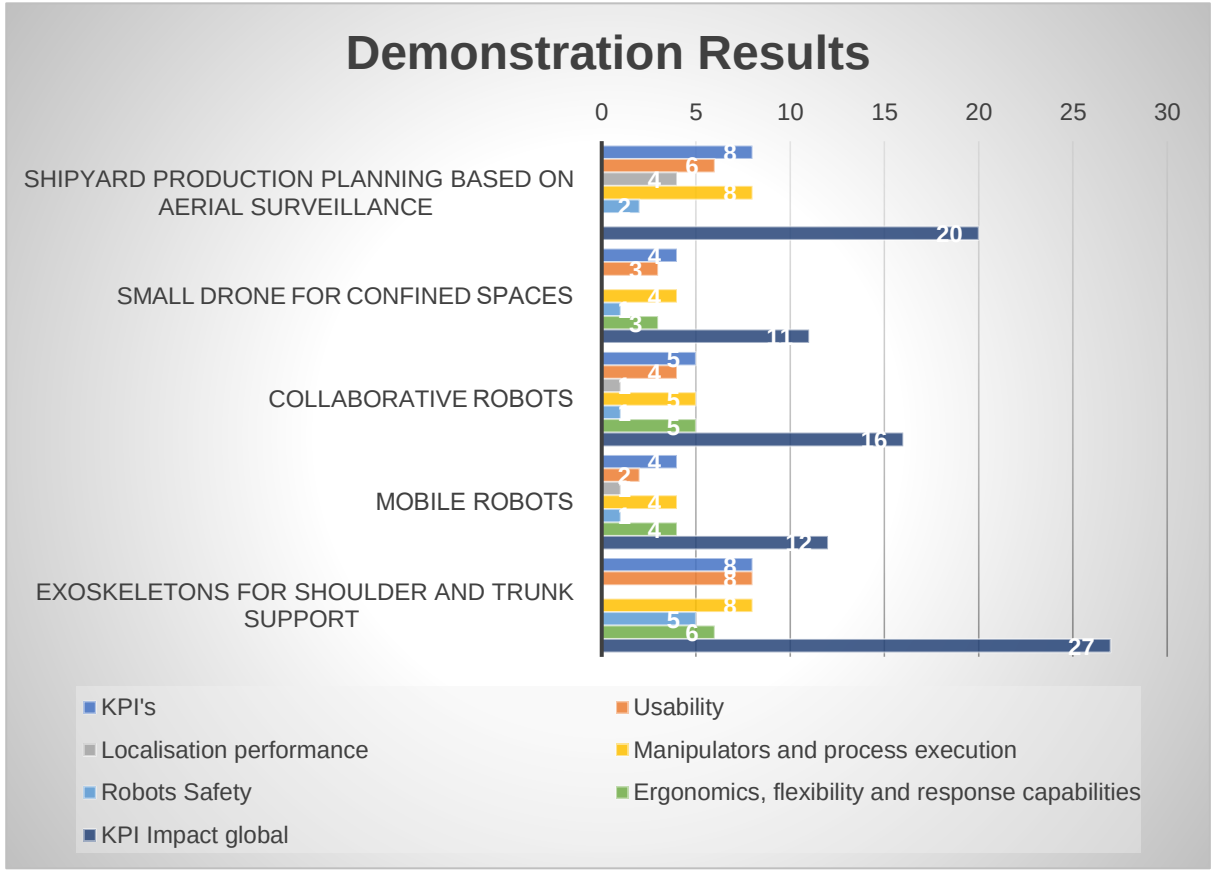
General Impact of the project outcomes





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General Impact of the project outcomes

We have prepared demos, where tech developers can give you handson:

Technologies	Location
Shipyard production planning based on aerial surveillance	Hall
Small drone for confined spaces	Hall
Collaborative robots	Workshop
Mobile robots	Hall
Exoskeletons for shoulder and trunk support	Hall

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the European Union

General Impact of the project outcomes

Didactic Factories Network

Scope

Open and real-scale demonstrators for workforce training at the EU level to accelerate the adoption of novel methodologies in shipbuilding.

Network of centres and general-purpose showroom facilities that will remain open to allow for training and skilling-up for given technologies.

Main Objectives

- Provide upskilling and re-skilling of shipyards workforce
- Demonstration of technologies that could be used to advance shipyard processes
- Provide infrastructure for third parties to test new technologies and solutions (technology developers and system integrators)

Funded by the European Union

General Impact of the project outcomes

Mari4 alliance community

50 participants per event workshop

Workshops & Trainings

- 1st Workshop.
- 2nd Workshop
- 3rd Workshop
- 4th Workshop (AIMEN 14th November 2024)

Replicability and cross-industry technology scouting

- Benchmarking between the developed technologies and already existing ones, taking advantage of the Didactic Factories Network.
- Formulating more robust recommendations to SME-shipyards (Open access paper).
- Openly accessible ***Best Practice Handbook, Public dataset, 3 deliverables (When end of the project – 1st week of December)***

1st Workshop

2nd Workshop

3rd Workshop

Funded by the European Union

The Team and Acknowledgement

Call topic MG-3-7-2020: Improved Production and Maintenance Processes in Shipyards

Shipbuilding and ship maintenance industry

aimen TECHNOLOGY CENTRE
BALance® Technology Consulting
BRODOSPLIT Member of DIV GROUP
CANONICAL ROBOTS
CMTZ Center of Maritime Technologies gGmbH
deepblue CONSULTING & RESEARCH
EWF
GIZELIS ROBOTICS
GHENOVA
INESCTEC
IUVO
LMS Laboratory for Manufacturing Systems & Automation
NETHERLANDS MARITIME TECHNOLOGY
nodosa group
Sant'Anna Scuola Universitaria Superiore Pisa
psc_ TRANSITION TECHNOLOGIES
TUHH Technische Universität Hamburg
WEGEMT EU MARINE UNIVERSITY ASSOCIATION

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Thank you!

Catalogue
of technologies

MARI4YARD

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4th Workshop - AIMEN Technology Center, Spain

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