ACROBA

connect & produce through agile production

D8.6 Sustainability plan v.2 – Part A

WP8

Robocoast EDIH

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ROBOCOAST EDIH Digital Innovation HUB

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	Name and Surname	Role in the Project	Partner(s)
Author(s)	Juha-Pekka Alanen	WP8 Leader	ROB
Reviewed by	Congyu Zhang Sprenger	WP6 Leader	BFH
Reviewed by	Adrian Ripoll Moncho	WP5 Leader	NUTAI
Approved by	Norman Urs Baier	Project Coordinator	BFH

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The ACROBA project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017284.

Executive Summary

Projects inherently have defined beginnings and ends, and ACROBA, a Horizon 2020-funded initiative, is no exception. Yet, ensuring the continuity and lasting impact of its innovative outcomes requires careful planning. This Sustainability Plan is dedicated to establishing the foundation for the ACROBA platform's long-term viability, far beyond the project's official end date. The European Commission's support has been instrumental in reaching short-term goals, including the development of five Pilot Lines that showcase the ACROBA platform's adaptability across diverse industrial settings. ACROBA's modular architecture not only simplifies integration into existing production lines but also allows the addition of new modules, enabling future expansion and increased flexibility.

The current economic climate presents unique challenges, particularly with elevated interest rates, which have made companies more cautious about new investments. This trend adds complexity to planning and strategizing for sustainable growth. Nevertheless, this Sustainability Plan outlines the strategic steps ACROBA is taking to ensure its impact endures. By addressing options for effective exploitation and establishing a roadmap for durability and

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growth, ACROBA is poised to contribute meaningfully to industry and education. This foundation will help ensure that the ACROBA platform remains a resilient and valuable solution, adaptable to evolving market needs. This Part A of the is a public version of the document.

1 Introduction and Objectives

The ACROBA project, funded by Horizon 2020, unites a consortium of 16 partners across 8 countries, blending expertise from research institutions, SMEs, and large companies. Led by BFH as the project coordinator, the consortium is focused on developing a cognitive robotic platform that enhances the agility and competitiveness of manufacturing SMEs. Below is an overview of the consortium members and their roles:

1.1 Consortium

Project Coordination

- **BFH** serves as the project coordinator, overseeing all organizational aspects to ensure the successful execution of project goals.

Platform Design, Reference Architecture, and Communication Protocols

- **Deusto** and **Sigma** work alongside **BFH** in designing the platform architecture and communication protocols. Together, these partners ensure the system's modularity and scalability, making it adaptable for a range of industrial applications aligned with agile manufacturing principles.

Cognitive Capabilities and Robot Module Architecture

- **BFH, Deusto, Sigma, Vicomtech, AITIIP, and iKOR** collaborate on developing the platform's cognitive capabilities and modular robot architecture, allowing for the implementation of adaptable cognitive functions. This work contributes to the platform's ability to respond to changing production needs.

Virtual Gym for Skill Development

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- **Vicomtech** leads the development of the **Virtual Gym** environment, a simulation and training platform created with Unity, where robots can practice and refine skills in a virtual setting before deployment. The Virtual Gym acts as a digital twin for the robot, significantly enhancing the platform's training and adaptability capabilities.

Agile Production Cells and Standard Robotic Tasks

- **BIBA, Sigma, IMR, and Nutai** are responsible for the development and testing of agile production cells, including the creation of a reconfigurable, sensorized robotic cell. They focus on defining and standardizing robotic tasks, ensuring flexible and efficient operations within various production settings.

Performance and Sustainability Evaluation

- **BFH** and IMR together with the use case partners make efforts to evaluate the platform's performance and sustainability. They define test scenarios and conduct result evaluations to ensure the platform meets both operational and environmental benchmarks, supporting its long-term viability.

Lights-Out Manufacturing Pilot Lines

- **CABKA, SteriPack, Moses, and AITIIP** have developed pilot lines for fully automated, lights-out manufacturing, highlighting the platform's potential for minimal human intervention. These partners designed specific use cases and customized equipment across three distinct production environments, demonstrating the system's adaptability.

Collaborative Assembly Pilot Lines

- **iKOR, ICPE, STAM, Vicomtech, and Nutai** focus on collaborative assembly lines, designed for full automation and agile production. They work on integrating the ACROBA platform into real production settings, enabling smooth adoption and supporting collaborative automation.

Dissemination, Communication, and Exploitation

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- **EMC2, Robocoast, and BIBA** oversee the project's dissemination, communication, and exploitation activities. They ensure that the ACROBA platform's results are widely shared with industry stakeholders through various channels, including webinars and conferences. Additionally, they manage strategies to maximize the impact and commercialization potential of the project's innovations.

1.2 Objectives of the ACROBA Project

The ACROBA project is designed to address the critical needs of manufacturing SMEs in Europe, where evolving market demands require a high level of agility and adaptability. Traditional automation systems, often rigid and tailored to specific large-scale applications, have historically struggled to meet these demands. By developing an agile, modular robotic platform, ACROBA aims to provide a solution that directly addresses these limitations. Below are the primary objectives of the project:

1.2.1 Respond to Market Needs with an Agile Solution for SMEs

In recent years, the demand for mass customization and rapid shifts in production requirements has intensified, especially in Europe's manufacturing sector. However, traditional automation systems lack the flexibility to easily adjust to new tasks or changing market conditions. The ACROBA platform aims to fill this gap by providing an agile, cognitive robotic system that supports quick reconfiguration and scalability, aligning with the AGILE manufacturing principles. This agile approach is essential for SMEs, which often face greater pressure to adapt but have limited resources for extensive retooling

1.2.2 Enhance Productivity Amid Stagnation in European Manufacturing

Over the past decade, productivity growth in Europe's manufacturing sector has remained near zero, largely due to the lack of adaptable technologies that can meet the needs of smaller operators. By introducing a flexible and cost-effective robotic solution, ACROBA aims to reverse this trend, enabling SMEs to enhance productivity and maintain competitiveness in an increasingly demanding global market. This objective reflects a broader ambition to contribute to economic sustainability and resilience within the European manufacturing ecosystem

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1.2.3 Develop a Modular and Cognitive Robotic Platform

ACROBA is creating a cognitive robotic system that integrates AI-driven modules and adaptive capabilities, making it highly customizable for a range of industrial applications. The modular approach allows the platform to be adapted to different production scenarios, ensuring that the system can support various manufacturing processes without the need for extensive reprogramming or redesign

1.2.4 Support Cost-Effective Automation for SMEs

High costs and technical complexity have traditionally hindered SMEs from adopting advanced automation. The ACROBA project specifically targets this issue by developing a solution that is both affordable and user-friendly, lowering the barriers to entry for smaller manufacturers. The result is a system that allows SMEs to enhance their productivity and adaptability without incurring prohibitive expenses

1.2.5 Integrate Human-Robot Collaboration and Autonomous Production

ACROBA's design includes pilot lines that showcase both human-robot collaborative applications and lights-out (fully autonomous) manufacturing environments. These pilots demonstrate the platform's flexibility and applicability across different production settings, emphasizing the potential for increased productivity and adaptability within agile manufacturing frameworks.

1.2.6 Provide a Virtual Training and Testing Environment

The Virtual Gym, primarily developed by Vicomtech, functions as a digital twin, allowing robots to practice and refine skills in a virtual space. This enables manufacturers to simulate and test processes before deploying them on the production floor, saving time and reducing the risk of costly errors. This environment is especially beneficial for SMEs, as it provides a controlled and accessible method for ongoing skill development and adaptation.

1.2.7 Drive Dissemination and Adoption of Advanced Robotics

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The ACROBA consortium is committed to ensuring that its innovations reach a wide audience and foster adoption across Europe. Through a variety of dissemination and communication activities—such as webinars, demonstration events, and industry conferences—the project aims to build awareness and promote the platform's benefits. These activities are essential for encouraging widespread adoption and supporting SMEs in embracing agile manufacturing solutions.

By meeting these objectives, the ACROBA project aligns with its goals of promoting innovation, competitiveness, and sustainability within the European manufacturing sector. With its focus on cognitive robotics and adaptable automation, ACROBA aims to significantly improve the agility and productivity of manufacturing SMEs, addressing long-standing challenges and supporting growth in a rapidly evolving market.

2 Joint Venture as the Key to Project Sustainability

To secure the long-term sustainability and impact of the ACROBA project, five core consortium members (BFH, NUTAI, AITIIP, Robocoast and IMR) are establishing a joint venture startup company based in Finland. This startup will be the central entity for managing intellectual property (IP) and trademarks, ensuring that the innovations developed within the project continue to benefit the European manufacturing sector. A shareholder agreement is currently being finalized to define roles, responsibilities, and governance within the startup.

2.1 Role of the Joint Venture in Sustaining ACROBA Outcomes

Initially, the startup's activities will focus on IP and trademark management, serving as a custodian of the project's intellectual assets. Rather than providing turnkey robotic solutions or managing large automation projects directly, these services will be primarily offered by industry partners and certain consortium members. This strategic approach allows the startup to operate as a streamlined organization, concentrating its resources on overseeing IP rights, certifying third-party solutions, and protecting the ACROBA trademark.

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3 IPR Management

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Intellectual property (IP) and knowledge assets needs to be seen as strategic business assets to capitalize their value. Effective IP management can result in business advantages and further funding opportunities. It is important to evaluate different strategies for improving the return on investment of IP generated in ACROBA- project.

IP protection is essential if the aim is to maximize the return on investment. By protecting the IP, a more secure revenue can be ensured in a situation, where competition exists. Protected IP can prevent competition from entering the same market and strengthen the market value of the company. On the other hand, it needs to be evaluated, what is the cost of protection against the expected return on investment. For example, in fast evolving industries it might be more effective to apply for a utility patent instead of a patent. Securing the return on investment by protecting the IP also encourages future financing of research and development activities.

In a joint study Intellectual property rights and firm performance in the European Union (2021) carried out by the European Patent Office and the European Union Intellectual Property Office, a strong association between ownership of IPs and improved economic performance has been found. According to the analysis, SMEs that own IPs, have 68% higher revenue per employee, than SMEs that do not own IPs at all.[1] In the light of the study, an effective IP strategy can bring significant competitive advantages.

automation.

4 Business Plan and Ecosystem for Joint Venture

Inflation has been steadily on the rise since 2020 and during 2021-2023 the inflation rate has been high, climbing steadily until October 2022 when it reached 10.6% in the euro zone area, according to ECB.

This has had an **impact on the ACROBA project pilot line's forecasts and industrial investment forecasts**. In June 2022 the inflation rate varies from 6.1 (Malta) to 22% (Estonia), which makes it difficult to predict exactly the selling prices that the ACROBA project can deliver as a product.

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The industry may be less likely to invest in new technology because of rising expenses, but it may also be prompted to use new robotics and intelligent systems to contain costs. This could serve as a signal for ACROBA to concentrate on attracting early adopters by spreading the word about the ACROBA platform, finding interested companies with the help of Digital Innovation Hubs (DIH) as well as making contracts with the appropriate industrial integrator companies in every country.

4.1 Future Platform Adopter

Some calculations have been made to assist future adopters to calculate the ROI value and costs savings expected vs conventional automation and the cost required to automate manual process with high load of hardware/equipment required:

Table4 - ACROBA Cost Savings for Future Platform Adopters

Description of Tasks	Cost required	Weight over the total (%)	ACROBA cost savings vs conventional automation (%)	ACROBA solution cost saving (€)
Hardware/Equipment	169,740.00 €	72.97	10%	16,974.00 €
Management	7,000.00 €	3.01	20%	1,400.00 €
Hardware Engineering	11,880.00 €	5.11	10%	1,188.00 €
Software Engineering	15,000.00 €	6.45	50%	7,500.00 €
Installation	15,000.00 €	6.45	10%	1,500.00 €
Commissioning	14,000.00 €	6.02	50%	7,000.00 €
TOTAL	232,620.00 €	100.00	15.29%	35,562.00 €

4.2 Costs Evaluations Tools of Creation of a Digital Twin

Digital Twin (DT) is a digital replica of a system, a machine, a production line, or an entire factory. DT is a key factor to exploit ACROBA at a production site. Our observation in Finland has revealed, that in the SME sector, Digital Twins are almost non-existent. Hence, Robocoast is studying the costs of creating of a Digital Twin for SME in Finland, and steps SME's need to take to deploy a DT. Currently we have some insight of the costs of a basic setup of the digital replica of the environment. These figures will be updated later with the knowledge gained during the AOSL, where one focus will be what kind of DT is needed in order to benefit of ACROBA platform, and how to reach the TRL level 5 to be able to obtain ACROBA. The following cost estimates do not cover the functionality of a production line in Digital Twin, but just the creation of the environment.

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4.2.1 Scenarios

The following three Scenarios are possible examples for the creation of a Digital Twin of a production line.

1) Scenario Small: one machine, area 20 m2
2) Scenario Medium: One line of machines, area: 100 m2
3) Scenario Large: Several lines of machines, area: 500 m2

4.2.1.1 Data capture

Several different methods to capture the As-Built situation can be used. We are considering three of them.

1) Mobile Scanning
2) Terrestrial Scanning
3) Photogrammetry

Mobile Scanning: The scanning happens on-the-fly by moving through the area of interest.
Pro: Easy and fast to deploy, little preparation or post treatment, medium costs
Con: Medium resolution and accuracy

Terrestrial Scanning: Scanning is done on several fixed positions.
Pro: High resolution and accuracy
Con: Time consuming, good planning necessary, high costs

Photogrammetry: 3D data is computed based on picture data
Pro: Easy to deploy, easily scalable, low cost
Con: Low accuracy

4.2.1.2 3D Model Type

In order to use the 3D data in a digital environment it is necessary to convert it to a format which can be read by the interface. We consider two basic types here.

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1) Surface Models
2) Primitives Models

Surface Model: The 3D model consists of a surface mapped onto a point cloud. Depending on the point cloud data and the method used for the mapping the result of the surface model can vary drastically. The used exchange format plays a role in the available features of the model.

Primitives Model: The 3D model is a collection of 3D primitive bodies which represents and fits the As-Built situation the best considering the level of detail. The level of detail is the most important factor in describing the specification for this 3D Model.

4.2.1.3 Example Cases

Scenario Small, Photogrammetry, Surface Model

The data acquisition can be done by a series of high-resolution photographs and should not take more than one hour. The computing and post treatment of the model can be done within a couple of hours.

Estimated costs: 400 – 800 €

Scenario Medium, Mobile Scanning, Surface Mode

The data acquisition is done with a mobile scanner and should be estimated with one day. Post processing of the scan data and point cloud should also be estimated at one to two days.

Estimated costs: 2500 – 4000€

Scenario Large, Terrestrial Scanning, Primitives Model

The data acquisition should be estimated at three to five days with a one-to-two-man team, depending on the conditions. Post processing of the scan data and point cloud should be estimated at two to three days. Creating the 3D Primitives Model with a low level of detail should be estimated with one week of design work.

Estimated costs: 7000 – 13000€

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4.2.1.4 Next steps in Digital Twin study

During the AOSL testing we will gather more real numbers about the costs of a creation of a Digital Twin for ACROBA. These figures will help a potential customer to prepare for becoming an ACROBA user and making the Digital Leap to the world of Agile Manufacturing.

4.3 Co-operation with European & Other platforms

4.4 European Digital Innovation Hubs

Three of the ACROBA partners are coordinating a regional EDIH in their countries. These will provide ACROBA project the basic network to reach out their respective partnering EDIH's. Also, DIH² provides access to more than 100 manufacturing industries DIH's.

EDIH partners of ACROBA:

- **EMC2** – DIVA EDIH
- **IMR** – FxC EDIH
- **ROB** – Robocoast EDIH, around 50% of Finnish exporting companies in the region

4.5 European Fast-track scheme

The current funding bodies that are implementing the Fast Track are Knowledge and Innovation Communities (KICs) of the European Institute of Innovation and Technology (EIT) for selected funding schemes and EISMEA for EIC Pathfinder and Transition projects. The EIC Accelerator supports individual Small and Medium Enterprises (SMEs), in particular Startups and spinout companies to develop and scaleup game-changing innovations. In some cases, small mid-caps (up to 500 employees) are supported.

These funding schemes can become convenient for a joint-venture creation, and to assists third parties to find proper funding schemes.

4.6 Single Entry Point (SEP)

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The intention of SEP is to make the most promising developments of ACROBA last over time, after the conclusion of the project. It aims to be a window to the world and at the same time trying to keep the consortium alive and operational. The SEP will be a point of contact for potential future services that may be developed by the ACROBA partners, as well as potentially being a point of sale for any of the planned KERs. SEP will be materialized in a website that will be available at the end of the project.

4.7 Licensing

Licensing can be a great option for a business plan for several of reasons. From the point of sustainability of a product, exploitation through licensing can have fast time to market, it requires less financing, involves fewer financial risks and licensing can provide faster returns. Through licensing a product can reach wider market sectors and geographical areas through different licensees in different technology areas. Licensing as a strategy can help to maximize the impact of results.

The licensee often has established markets, and the business plan is to increment their own technology and fill in a specified gap in the market. This way the new product or service can reach wide markets in reasonable time and resources. The licensee also has already acquired the expertise to exploit the IP and generate profitable business with it. Licensing can be a great way to exploit the IP if the IP owner does not have enough resources or expertise to launch the product to market..

4.8 Open-Source Software

Open source as a business plan can be utilized for example by building service infrastructure around the software, for example integration, training, and consultancy. Another strategy could be offering software as open source to support for example robots or specific hardware that a company produces to enhance sales.

When choosing the license, we must deliberate between permissive and copyleft licenses. Special attention must also be addressed to interoperability of different components and

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solutions. The decision to use open source as a business strategy must be justified in terms of the impact and business opportunities that the strategy has.

4.9 Standardisation

The benefits of standards for European industry are extensive. Standardisation activities are one of the key paths of the project exploitation to ensure the future adoption of the Platform. To maintain consistent quality and interoperability as the ACROBA ecosystem grows, an internal standardization framework is in development.

5 Target Sectors

The European industrial robotics market has been experiencing significant growth in recent years, driven by factors such as the robust manufacturing industry in the region, increasing demand for automation in various industries, and the adoption of Industry 4.0 technologies. The market is expected to reach $20.08 billion by 2025, growing at a CAGR of 9.02% during the forecast period. The automotive industry accounts for the largest share of the market, while other industries such as electrical and electronics, metal and machinery, and food and beverage are also expected to contribute to the market's growth. Germany is the largest market for industrial robotics in Europe, accounting for more than 40% of the market share, followed by Italy, France, and the United Kingdom. The increasing adoption of collaborative robots or cobots is expected to create new opportunities for the market in the region. Material handling is expected to be the largest application segment of industrial robotics in Europe, followed by welding and soldering, assembly, painting and dispensing, and inspection and testing. Overall, the European industrial robotics market is expected to continue growing significantly in the coming years.

5.1 General Trends

The industrial robotics market in Europe is being driven by several factors, including the robust manufacturing industry, increasing demand for automation, and the adoption of Industry 4.0 technologies. Trends driving the market include the need for flexible manufacturing systems and a focus on workplace safety. Key players in the market include ABB, KUKA, and FANUC,

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with Universal Robots and Yaskawa Electric Corporation also making a significant impact. While the automotive industry is the largest end-user segment, other industries such as electrical and electronics, metal and machinery, and food and beverage offer growth opportunities. However, the market also faces challenges such as the high cost of industrial robots and a shortage of skilled workers to operate and maintain them. Investment in education and training programs is needed to prepare workers for the jobs of the future.

5.2 ROS WITHIN ROBOTICS

ROS, or Robot Operating System, is an open-source framework for developing robotics software that provides a collection of libraries, tools, and drivers that can be used to build complex robotic systems. ROS is expected to continue to have a significant impact on the field of robotics due to its standardization, flexibility, innovation, accessibility, and collaboration. It provides a standardized platform for robotics development, making it more efficient and collaborative. ROS is designed to be flexible and modular, allowing for more efficient development and enabling developers to create custom robotic systems that are tailored to their specific needs. As an open-source platform, ROS allows for a high degree of innovation and experimentation, leading to the creation of new robotic systems and technologies. ROS is also accessible to a wide range of developers, from hobbyists to researchers to industry professionals, which can lead to a more diverse and inclusive robotics community. Finally, ROS has a large and active community of developers who collaborate on the development of the framework, leading to more rapid development and innovation, as well as a greater sharing of knowledge and resources.

5.3 POTENTIAL APPLICATIONS AND MARKETS

BIN PICKING

Bin picking robot applications are being used in a variety of industrial sectors, where the picking and placing of objects is a common task. Some of the industrial sectors using bin picking robot applications include automotive, electronics, logistics, pharma and food industries. Overall, bin picking robot applications are being used in a variety of industrial sectors where the automation of picking and placing tasks can lead to increased efficiency, productivity, and accuracy.

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COMPLEX ASSEMBLY

Complex product robotic assembly involves using robots to automate the assembly of complex products such as cars, aircraft, and electronic devices. Some of the applications of complex product robotic assembly and the industrial sectors involved are: automotive, electronics, aerospace, medical devices, and consumer goods.

Human-robot collaborative assembly (HRC) is an area of robotics that focuses on the safe and efficient collaboration between humans and robots in assembly tasks. Some of the current trends in HRC assembly are: Safety, Flexibility, Artificial intelligence (AI), Integration and sustainability.

PROGRAMMING BY DEMONSTRATION

Robotic programming by imitation using haptic tools is a field of research that aims to enable robots to learn tasks by imitating human movements through haptic feedback. One of the key trends in this area is the development of advanced sensing and feedback systems that capture the motion and force of human movements in real-time. Additionally, machine learning algorithms are increasingly being used to analyze and learn from human movement data, which helps to improve the accuracy and efficiency of robot movement.

Another important trend is the increasing focus on human-robot collaboration, which involves developing robots that can work alongside humans and adapt to their movements and preferences. This requires the development of interfaces and training programs that make it easier for humans to teach robots new tasks. Finally, virtual reality is being used to create more immersive and realistic training environments for users, allowing them to simulate the environment in which the robot will operate and provide a more intuitive interface for teaching the robot new tasks. Overall, these trends are helping to advance the field of robotic programming by imitation and pave the way for new applications in industries such as manufacturing, healthcare, and entertainment.

5.4 MANUFACTURING AS A SERVICE

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Specific technological (or non-technological) enablers or solutions that need to be addressed by the research or innovation activities. In order to achieve a consistent approach to the industrial challenges, one or more of the following areas have to be addressed. Some of them are covered by ACROBA scope, and others should be worked in other potential environments.

5.4.1 ZERO-DEFECT MANUFACTURING – QUALITY ASSURANCE – SELF-LEARNING SYSTEMS

ACROBA covered enablers:

- Integrated machine, fixture, tool, workpiece
- integration of intelligent, autonomous, self–adaptive
- Process adaption by self-learning
- Robust automation
- New measurement and inspection
- Development and integration of in-line or in-process
- Strategies for optimally combining and harmonising heterogeneous data such as images, geometry
- Plug-and-inspect data.

6 Competition

There is no history of products exactly identifiable to the ACROBA platform. Although they can be analysed partially.

7 Conclusion

As ACROBA moves closer to project completion, we look forward with confidence, knowing that the foundation laid through diligent planning and collaboration will ensure its enduring impact. This Sustainability Plan highlights the robust framework established to preserve and expand the ACROBA platform. The planned establishment of a joint venture startup, combined

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with the development of IP protections through trade secrets and trademarks, places ACROBA in a strong position to remain relevant and adaptable in the evolving landscape of industrial robotics.

Despite the challenges presented by the current economic climate, particularly the cautious investment environment influenced by high interest rates, ACROBA's vision remains resilient. The adaptability of the platform and the consortium's commitment to internal standardization will allow ACROBA to continue delivering value, supporting manufacturing SMEs, and driving innovation across the industry.

With these initiatives, ACROBA is set to evolve beyond the boundaries of the project, becoming a lasting asset that supports sustainable growth and competitiveness within the European manufacturing sector. This journey marks the beginning of ACROBA's enduring legacy in robotics and automation, ensuring its relevance and impact for years to come.

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[1] Intellectual property rights and firm performance in the European Union, 2021, European Patent Office & the European Union Intellectual Property Office

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