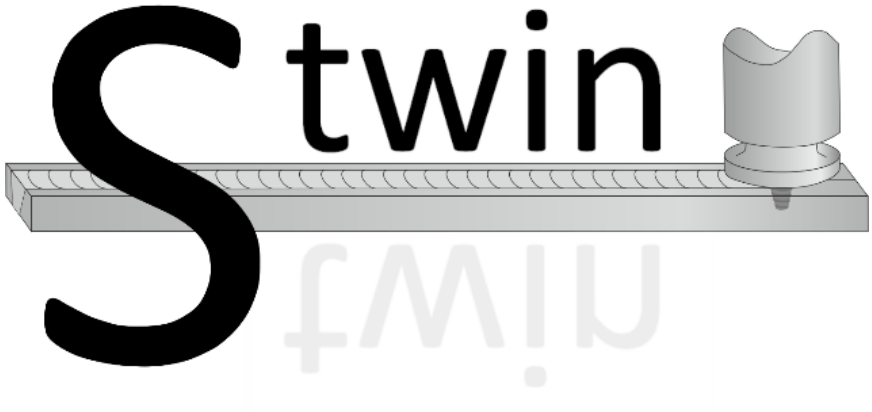
Funded by the European Union

Advanced, non-destructive technologies to improve friction stir welding of steel through artificial intelligence and smart digital twins (Acronym: STWIN)



Research Fund for Coal and Steel
Grant Agreement Number 101112504

Deliverable 6.5: Exploitation plan – First release

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1 Executive Summary

This document describes the proactive exploitation strategy of the STWIN project.

The exploitation of the innovative developed technology will occur in phases: project development, product development phase (1-year post project), global expansion phase (2-3 years post project) and global consolidation phase (4-10 years post project).

During the project execution, the EXPLOITT® methodology for industrial exploitation will be used. This process is divided into three main phases: technology assessment phase, business plan phase and competitive intelligence phase. In the technology phase the exploitable results of the project and their potential for commercialisation are identified. The business plan phase focuses firstly on characterizing the current market situation and subsequently on establishing a business model for the exploitation of the research. Benchmarking of competitors, stakeholder analysis, a PESTEL-analysis, a value proposition (gains, pains & to do) and the creation of a business model canvas are part of the business plan development. The last phase focuses on securing the competitive intelligence by streamlining the IPR management process.

2 Introduction

The aim of the exploitation plan is to maximize the impact of the project innovative technology on the society and the economy. Ensuring that the results are not only published in academic journal, but also that they are translated into industrial applications. This proactive plan enlarges the chances of utilizing the research results.

2.1 Overview of STWIN exploitation strategy

The exploitation of the STWIN technology will occur in phases, covering product development, initial exploitation, global expansion and global consolidation. These stages are detailed below:

Year 1 post project - Product Development

During this period, the consortium partners will look to move from proof-of-concept prototypes of the flexible FSW system, process control unit and beta versions of the software to be validated and debugged products. This will require significant investment, potentially from outside sources in the form of venture capital or loans.

Project information will be continued to be disseminated through the partner networks and the technology will be continued to be showcased at conferences and trade shows. Marketing campaigns will commence towards the end of this period.

Year 2 - 3 post project - Initial Exploitation

The first operating phase will be aimed at establishing a market presence in Europe. Gaining a market presence will require not only a sales route, but also the training of welding

personnel in the application of the STWIN system. This will be achieved through an accreditation scheme, whereby welders can obtain training in the use of STWIN.

Year 4 - 10 post project - Up-scaling

At this stage, the system is expected to gain a foothold in initial target markets. The next step will be to consolidate these markets and start pan-European expansion. This will be achieved by engaging more of the national welding associations, supply chain licensees and investors.

Further European expansion will depend on the local situation in the target markets, in particular the labour and overhead rates, because this will influence the batch size at which it becomes attractive to employ automation.

Although global expansion is not set to start officially until about 5 years post-project, opportunities may arise earlier due to the extensive global network of the project partners. Our primary focus will remain on Europe, as our main goal is to assist the European metalworking industry.

2.2 Project results identified at proposal stage

The paragraph below states briefly the project results that are identified at the time of writing the proposal of the STWIN project.

- Novel parallel kinematics robot allowing FSW of complicated geometries without losing payload and stiffness
- New manufacturing system for FSW of 3D joints in various steel grades and for dissimilar joints (steel-aluminium and sheets of dissimilar thicknesses).
- Digital Twin solution to establish the causal links between real-time measurement data and the weld quality and occurrence of defects.
- Expert systems based on multi-sensor process monitoring for real-time corrective actions to guarantee a high weld quality.
- Demonstration of the capabilities of real-time quality monitoring and control for 3D FSW applications under real circumstances, by the development of case studies.
- Demonstration of the technological, economic and environmental advantages of the new production method using demonstrators (loader cranes, vehicle differential, trailer).

3 Exploitation methodology

The exploitation of results will be done by adapting the EXPLOITT® methodology developed for H2020 project and validated previously by the European Commission.

EXPLOITT® is a methodology for industrial exploitation and take-up developed by IK4-IDEKO in the FOCUS EU-Project (1). This guided process is divided into three main parts: process for the development of an exploitation plan and take-up, process for the design and implementation of a competitive intelligence system, and clustering activities. The aim of this methodology is to develop a preliminary business plan and help carry out the take-up. For the sake of simplification, the clustering activities are considered out of the scope of the exploitation strategy to be implemented in STWIN.

Hence, the exploitation methodology to be developed in STWIN consists of three main phases: technology assessment, business plan, and competitive intelligence activities as depicted in Figure 1.

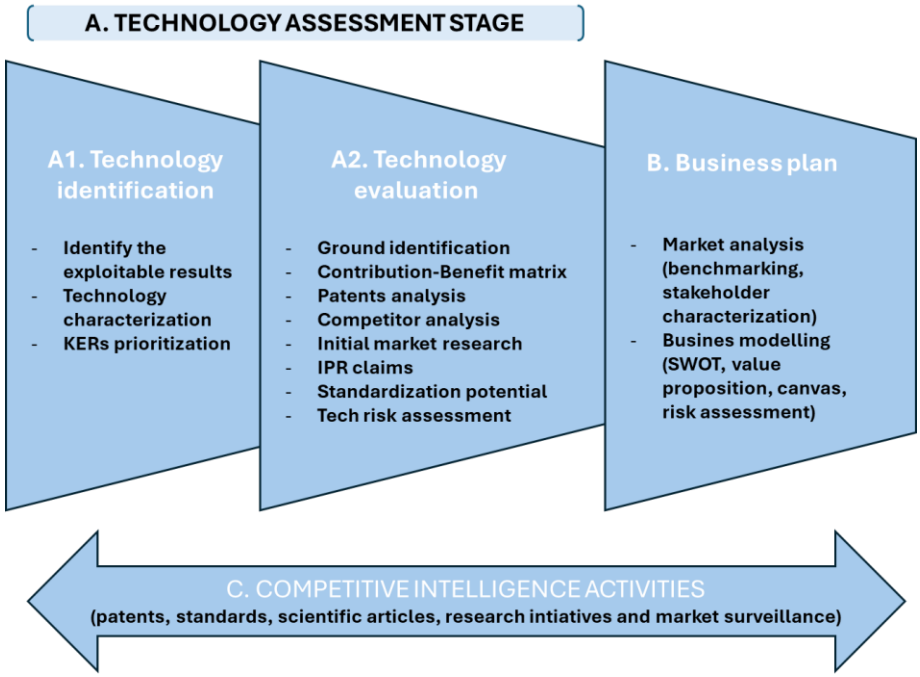


FIGURE 1 EXPLOITT ® METHODOLOGY FOR PROJECT RESULTS EXPLOITATION (ADAPTATION)

3.1 EXPLOITT® methodology

3.1.1 Phase A - Technology Assessment

The first phase *A - Technology Assessment*, identifies the exploitable results of the project and their potential for commercialisation on the market. Phase *A1 - Technology Identification*, starts with the identification and characterisation of exploitable result taking into account the potential customers, the added value and the preliminary estimate. At the end of this phase, it is essential to prioritise the technologies.

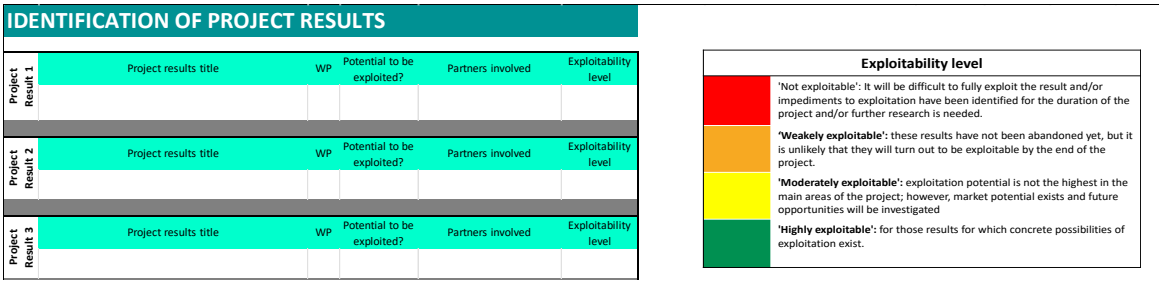
The main exploitable results will be identified and selected after that. This is followed by the next phase *A2 - Technology Evaluation*. The results are analysed in terms of market research, competitors, assessment of intellectual property rights, standardisation, and regulations, among others. After the technology assessment, the business plan is carried out with the aim of developing a preliminary business model of the most interesting exploitable key results.

Phases *A1 - Technology Identification* and *A2 - Technology Evaluation* will be implemented in STWIN as described below.

Phase A1 - Technology identification

Exploitable results will be identified, characterised and prioritized in this stage by all partners of the consortium.

To identify the project results, a dedicated template is created with the following information: the exploitable results title, work package, potential, partner involved and exploitability level. Each partner contributes to this part by taking as baseline the results mentioned at proposal stage. The goal of this phase is to identify the results that will be prioritized at the next stage. For it, it is essential to identify the exploitability level and the benefits in each result, and to choose those that show the best successful results. An example of this template is shown in the following Figure 2.



IDENTIFICATION OF PROJECT RESULTS

	Project results title	WP	Potential to be exploited?	Partners involved	Exploitability level
Project Result 1					
Project Result 2					
Project Result 3					

Exploitability level

- 'Not exploitable': It will be difficult to fully exploit the result and/or impediments to exploitation have been identified for the duration of the project and/or further research is needed.
- **'Weakely exploitable':** these results have not been abandoned yet, but it is unlikely that they will turn out to be exploitable by the end of the project.
- **'Moderately exploitable':** exploitation potential is not the highest in the main areas of the project; however, market potential exists and future opportunities will be investigated
- **'Highly exploitable':** for those results for which concrete possibilities of exploitation exist.

FIGURE 2 TEMPLATE TO BE USED FOR THE IDENTIFICATION OF THE MAIN PROJECT RESULTS

Once the exploitable results are identified, the characterization or the technologies involved is carried out. For each exploitable result, a detailed characterization table is completed by the STWIN partners involved in their development; an example (which may be subjected to some simplifications) can be seen in Figure 3.

CHARACTERIZATION OF PROJECT RESULTS

	Result 1	Result 2	Result 3	...	Result n
Partners involved					
Explotability Level					
Brief Description					
Innovativeness introduced compared to already existing Products/Services					
Unique Selling Point					
Product/Service Market Size					
Market Trends/Public Accepttance					
Product/Service Positioning					
Legal/Normative/ethical requirements (need for authorisations, compliance to standards)					
Competitors					
Prospects/Customers					
Cost of Implementation (before Exploitation)					
Time to Market					
Foreseen Product/Service Price					
Adequateness of Consortium Staff					
External Experts/Partners to be involved					
Status of IPR: Background (type and partner owner)					
Status of IPR: Foreground (type and partner owner)					
Status of IPR: Exploitation Forms (type and partner owner) e.g., direct industrial use, patenting, technology transfer, license agreement, publications, standards					
Which partner contributes to what (main contributions in terms of know-how, patents, etc)					
Partner/s involved expectations					
Sources of financing foreseen after the end of the project (venture capital, loans, other grants)					

FIGURE 3 TEMPLATE TO BE USED FOR THE CHARACTERIZATION OF PROJECT RESULTS

Based on the identification and characterization outcomes, the results are then further prioritized to derive the project KERs. The main objective of the **prioritization** is to facilitate the selection from among all the exploitable results those that are both most interesting and most feasible for turning into exploitable results or products. The selected results will be prioritized using scores based on the following criteria: innovativeness of the result, exploitability level, and the impact in industry. The KERs will be prioritized based on the weighted scores from the partners. The comprehensive evaluation of the most important exploitable results is performed after in *Phase A2 – Technology evaluation*.

Phase A2: Technology Evaluation

This second stage of the exploitation methodology consists of eight phases requiring an in-depth analysis consisting of the following elements: ground identification, contribution-benefits matrix, patent analysis, competitor landscape analysis, market research, Intellectual Property Rights (IPR) and exploitation claims, standardisation process, and risk assessment. To carry out the technology evaluation, only the top 3-5 KERs (as per the prioritization activity) will be further investigated due to the complexity of the following processes, and also taking into account that many EU projects developed are pre-competitive technologies.

- **Ground identification**: this phase starts with the identification of the exploitable result base to determine how the project KERs will be exploited. This is followed by the **contribution-benefit matrix**, which is based on the cooperation between the partners and the common desire for a solution.
- The **patent analysis** assesses the state of the art and shows how the results go beyond it in terms of innovative, scientific and/or technical quality.
- The **competitor landscape analysis** is then carried out to provide a global vision of who the main competitors are and what their characteristics and products are.
- This is followed by **market research** to know the existing demand or business volume of three selected KERs for technology assessment.
- Then, the **IPR description** focuses on the different agreements that can be used for knowledge transfer purposes.
- In order to build a bridge between research and the market, a **standardisation potential assessment** will be carried out to enable the quick and easy transfer of research results to the European and international market.
- Taking all this information into account, the last part is to analyse the possible risks that may arise and jeopardise the exploitation of the selected KERs. This **risk assessment** chapter includes a risk matrix and a risk priority map of the project and of each KER. The risk matrix includes all potential risks classified according to their origin: partnership risks, technological risks, market risks, IPR risks, financial risks or environmental risks. The priority map is an action tool aimed at analysing, identifying and prioritising the main potential risk factors to be addressed.

3.1.2 Phase B: Business Plan

The second *Phase B – Business plan* focuses on establishing a comprehensive baseline of the current market situation and trends as well as other traditional Key Performance

Indicator (KPIs) of the existing market today (e.g., size, growth rate). Once the market has been characterized successfully, a business model will be established, exploiting the competitive edge of the STWIN solutions compared to existing competitors and offers. Several different interactive tools will be employed for this purpose.

In order to be able to estimate and evaluate the commercial potential and subsequently to develop an uptake strategy for the concrete market, it is important to take stock and deeply understand the needs of the customers, suppliers, competitors and the value of the existing products on the market and gaps in their offering (including functionalities or manufacturing techniques but also pricing or sales strategies) to see where innovation can take place and in which areas the STWIN solutions can demonstrate a competitive advantage.

Following the establishment of a solid inventory and baseline of the market landscape, adequate and effective business models will need to be elaborated. For this, several proven methodologies are applied (see also section 6 - Business modelling approach) to help the consortium members not only in characterizing and profiling the solution they are creating but also to highlight its eventual clear competitive edge in one arena or several at the same time.

3.1.3 Phase C: Competitive intelligence

The third *Phase C - Competitive Intelligence* activities will also be addressed in the STWIN project, especially with the objective of streamlining the IPR management process.

Competitive Intelligence (CI) is an ethical, systematic and collaborative process, supported by specific tools for obtaining, analysing, distributing and interpreting relevant information about a competitive environment in order to generate an ideal context for taking exploitation decisions. CI adjusts the course of developments based on what is happening in the competitive and technological environment associated with the project.

The next bullets summarise the key intelligence topics to be covered in the second half of the STWIN project:

- **Patent surveillance**: it is necessary to study and monitor the state of the art related to performed research and the results to be obtained within the project.
- **Norms and standards surveillance**: the norms and standards relating to the developments must be known and changes must be monitored.
- **Scientific articles surveillance**: scientific and technological developments that may influence the project results.
- **Competitor monitoring**: knowing what products are placed on the market and their evolution can help decision making when bringing our developments to market.
- **Monitoring other European projects** approved on the same topics.
- **Monitoring market evolution**: it is important to know at all times whether market needs have changed or are being met from other emerging technologies.

It is important to mention that some of these points will also be addressed earlier in *Phase A* described before, therefore the main objective this *Phase C* is to complement and expand those findings.

4 Individual exploitation plans of STWIN know-how

Considering as starting point the exploitation avenues identified in the latest update of the Grant Agreement, the following Table 1 updates and expands such content.

TABLE 1. INDIVIDUAL EXPLOITATION PLANS

Partner	Individual exploitation strategy description
CIDAUT	The integration of AI based algorithms (machine learning and deep learning) into a single platform along with process data to monitor and optimize the FSW process will serve to expand the services catalogue of the company. It is also expected to produce scientific and non-scientific publications of the subject. After the project finishes, CIDAUT will work to expand the features of the Digital Twin platform and replicate it to monitor other manufacturing processes under research at Cidaut The development of simulation methodologies based on actual testing results to predict the behaviour of FSW joints made up different materials and thicknesses will be exploited through scientific publications, workshops and conferences to reach industry and academia stakeholders. Besides, both exploitation avenues will also consider the development of MSc and PhD Thesis during and after the project execution. Cidaut will also liaise with the University of Valladolid to include part of the knowledge generated in STWIN in relevant graduate or post-graduate programs taught in the Faculty of Industrial Engineering.
GRANALU	FSW between inox Steel and aluminium is a major challenge to be analyzed and explored in terms of its feasibility. Considering applying FSW to join aluminium plate and inox steel reinforcement plate it is already a major step forward. It would let GRANALU to achieve a new alignment in the production process and finally, an eventual reduction of takt time of the assembly operation. Further investment analysis should be executed to confirm the convenience of such implementation. Secondly, the constraints and restrictions of this manufacturing technology would lead GRANALU to eventually adapt their product to achieve an optimized lead time of vehicles that implements such a reinforcement on the floor of the tipper box. However, this second point should be discussed with the Engineering Department and the Commercial Department. Further investment analysis should be executed to confirm the convenience of such implementation. Implementing a new welding technology will increase the internal knowledge of GRANALU's production teams, increasing their expertise on the field of assembly. In addition to this, it will open the door to eventual other applications of FSW technology, which is widely known and explored in other sectors such as train, aeronautics or space.

BWI	Understanding the technical feasibility of welding the targeted materials and thicknesses is a key outcome of this project. The insights and expertise gained will be widely shared with both the industry and the scientific community. This dissemination will occur through publications, workshops, or conferences, ensuring the knowledge reaches relevant stakeholders. Furthermore, the acquired expertise will be leveraged to provide technical consultancy services, assisting other companies and research groups in addressing similar challenges and advancing their own projects. The development of a methodology for quality monitoring of welded joints, supported by advanced AI technologies, is an important aspect of this project. The outcomes related to this innovation will be shared widely through publications in both scientific journals and accessible non-scientific platforms, ensuring a broad dissemination to diverse audiences. In this way, consultancy services can be provided to organisations seeking to implement or refine such methodologies. To further promote industrial application, technology transfer will be pursued, enabling external companies to adopt and benefit from the cutting-edge solutions developed in this project.
ISEND	In this project it is essential to have different methods for checking the quality of the weld. In this sense, ISEND brings its experience in the use of non-destructive methods: Eddy Current and Magnetic Field Leakage. The results of this inspection will give information about the surface and subsurface quality of the welds and will help to strengthen the rest of the Quality supervisors. The system developed by ISEND will allow companies and organisations to know the presence of defects or irregularities in their welds and at what specific point these occur, allowing them to establish thresholds based on the signal from which the weld can be considered suitable or unsuitable, based on the results produced by the software. This service can be provided to companies and organisations that wish to control the quality of the weld joint and this will provide useful information for optimising the process parameters.
STIRWELD	Stirweld may participate in the final phase of the project to integrate AI-driven algorithm models for process control, as well as advanced weld inspection techniques utilizing Eddy currents. In STWIN, Stirweld 's strategic focus also extends to tooling. The objective is to reinforce the durability and performance of the existing tool range, particularly for aluminum/steel applications, while exploring new classes of tool materials.
SSAB	Increased understanding of FSW in high strength steels. Is this technology possible to use in extra high strength steels and what mechanical properties of the welded joint can we expect? Furthermore, one of our most challenging obstacles to overcome is fatigue of fusion welded joints,

	especially for high strength steels since upgrading to high strength steels result in higher operating stresses. FSW might be a method that would provide a much higher resistance to fatigue failures. Dependent on the outcome it might be possible to provide recommendations on FSW parameters for users/customers that use high strength steels in their fatigue loaded applications.
HORSE	FSW technology is new to Horse, and the main objective is to understand the limits of the technology for the application in joining revolution parts subjected to high stress. The application of this technology could lead HORSE to make manufacturing processes less costly and less polluting, while also producing a more compact and higher-performing product for customers. In addition to understanding the limits of the technology, HORSE's goal is also to understand the quality and manufacturing issues that this technology might present
HIAB	HIAB will benefit from understanding: - The mechanical properties of friction stir welds in high strength steels (up to and including S960) in thicknesses up to 8 mm. - The obtainable fatigue resistance (FAT-value) of FSW-welds in high strength steel - The best method to control/assure the quality of full penetration FSW butt welds. - The repeatability of the FSW process - The feasibility of industrial implementation, especially for 3D-welding applications
E6	Element Six specialises in FSW tools and has developed a patented tool designs that can offer enhanced durability and improve welding efficiency. We utilise high-temperature superhard materials like PCBN for our tools, ensuring long-lasting performance across a broad range of steel grades. Element Six invests heavily in R&D, collaborating with universities and research institutes to stay at the forefront of FSW technology. We ensure that all our tools meet industry standards and have a robust quality assurance program in place. Additionally, we can potentially license our patented designs to other manufacturers, creating a steady revenue stream. By focusing on these strategic areas, Element Six successfully exploits the potential of FSW tool manufacturing, establishing themselves as a leader in the industry.
TRICYLON	Tricylon's exploitation strategy focuses on leveraging the innovative developments from the STWIN project to enhance its technological

	offerings and strengthen its market position in the advanced manufacturing sector. Key elements of our exploitation strategy include: 1. **Product Development**: Tricylon aims to develop a commercially viable adaptive robot control system tailored for advanced 3D friction stir welding (FSW) applications in steels. By integrating real-time data analysis infrastructure with adaptive control, this system will address complex welding scenarios and improve efficiency in manufacturing processes. 2. **Knowledge and Expertise Transfer**: Tricylon will collaborate with academic institutions and industrial stakeholders to disseminate knowledge on the feasibility and benefits of 3D FSW technology. This includes publishing research papers, presenting at industry conferences, and organizing workshops to promote advanced FSW applications. 3. **Market Deployment**: Initial efforts will focus on industrializing 3D FSW technologies for steel welding. Tricylon plans to target niche sectors where advanced FSW can deliver significant cost and quality advantages, such as the automotive and construction equipment industries. 4. **Intellectual Property (IP) Strategy**: Patent protection will be sought for key innovations, particularly in the adaptive robot control algorithms and the integration of real-time monitoring systems. 5. **Long-Term Goals**: Beyond the immediate commercialization phase, Tricylon envisions expanding the application of its technologies into multi-material welding and other manufacturing processes, solidifying its leadership in smart manufacturing solutions.

5 IPR management guidelines

During the proposal stage, the STWIN Consortium identified a set of measures to manage knowledge acquired during the project, including continuous identification, monitoring and qualification of tangible and intangible results that should be either kept confidential, legally protected (via patents and licences where appropriate to ensure IPR), disseminated or transferred to third parties. Besides, all issues regarding confidentiality, pre-existing know-how, agreement on exploitation rights, and clarification of everyone's rights and obligations have been covered in the Consortium Agreement (CA) signed by all partners at the start of the project. During the project execution, STWIN activities will be directed towards industrial outcomes and technological progress and, therefore, an **IPR Management Strategy** is required. Generally, background IP will remain the sole property of its owner unless otherwise specified, as it has been acquired/generated prior to or independently of the project. In jointly owned foreground cases, the consortium will seek to identify one single owner of the IP (even though several contributors/inventors may be identified) that will exploit the IP on behalf of the others.

The following Table 2 gathers the background and foreground knowledge identified by the partners, at the moment of submitting this report.

TABLE 2 BACKGROUND AND FOREGROUND KNOWLEDGE INVOLVED IN STWIN.

Partner	Background knowledge	Foreground knowledge (expectation)
CIDAUT	1. Experience in the application of ML algorithms and neural networks for decision-making purposes. 2. Digital Twin development to control (without intervention) industrial processes 3. Materials testing methodologies at coupon and component scales 4. Development of material cards of metallic materials 5. Development of tailored simulation methodologies and models for different applications (automotive, aerospace, industry)	1. Adaptive Digital Twin solutions integrating AI-based algorithms. 2. Deep Learning algorithms for weld quality monitoring (weld defects detection) 3. Real-time data management 4. Post-welding process simulation. 5. Data representing the behaviour of different kinds of FSW joints
GRANALU	1. Expertise in traditional welding technologies (MIG, TIG) 2. Expertise in aluminium welding 3. Expertise in high volume and heavy components joints. 4. Expertise in managing big structures through welding parameters.	Knowledge about the practical application of FSW for execution of dissimilar metal welds (steel-aluminium): process parameters, tools, process robustness, economic benefits. Application of the automatic FSW process, to obtain a constant weld quality, less dependent of the welder. Aesthetic improvements in the final product
BWI	BWI is a recognized authority in the field of welding technology, with extensive knowledge and experience in: 1. Material properties and weldability: BWI is familiar with a wide range of steels, including low-carbon steels, high-strength steels, stainless steels, and advanced alloys. They understand how the chemical composition, microstructure, and mechanical properties of these materials influence weldability. 2. Welding processes: Proficient in different welding techniques; and deep understanding of how specific	1. Material properties and weldability: Understanding the effects of FSW on steel microstructures, tool-material interactions and surface preparation requirements. 2. Welding processes: Optimising FSW parameters, managing heat input and adapting FSW equipment for steels. 3. HAZ and microstructural changes: Investigating grain refinement, phase transformations, residual

	welding processes impact heat input, cooling rates and subsequent weld quality for steels. 3. HAZ and microstructural changes: Comprehensive knowledge of the HAZ in steels during welding, including phase transformations and the formation of undesirable microstructures. 4. Failure mechanisms: Analysis of welding-related failures, and strategies for preventing weld defects through process optimisation. 5. Standards and testing: Familiarity with international welding standards (e.g., ISO and EN) and their implications for weldability assessments.	stresses and defect prevention in the FSW welds. 4. Failure mechanisms: Identifying and mitigating FSW-specific defects (e.g., voids, cracking) through process control and monitoring. 5. Standards and testing: Applying relevant standards, using non-destructive testing, and employing real-time quality monitoring to ensure weld integrity, experience with process monitoring systems for FSW, with insights that can be transferred to other welding techniques.
ISEND	1. Experience in the application of surface and sub-surface defect detection systems based on NDT such as eddy current (electrically conductive materials) and magnetic flux leakage (ferromagnetic materials). 2. Design and development of electronics, software and probes for specific applications. 3. Software development for detection and inspection data treatment (online and offline inspection).	Real-time quality monitoring of FSW. NDT system that allows online monitoring of welding quality. Real time analysis of the quality measurement data, and enabling of real-time corrections.
STIRWELD	1. Patents and very good know-how related to the FSW process; 2. Design and manufacturing of tools for FSW applications; 3. Optimization of process parameters to achieve optimal tool performance in FSW applications.	Improved knowledge about FSW of steels or dissimilar joints (practical experience, process parameters, required tools, …), which will serve to address new applications and expand STIRWELD's customer portfolio. Knowledge about real-time process monitoring and control with corrective actions, which will serve to improve STIRWELD process control systems.
SSAB	Good knowhow about what typical mechanical properties can be expected	Greater knowledge about the behaviour of several steel

	of fusion welded joints, including HAZ in high strength steels. Very good knowledge about suitable fusion welding methods for high strength steels. Superior knowledge in fatigue behaviour of welded joints in high strength steels including PWT of welded joints in order to improve the fatigue resistance.	grades in their pre- and post-welded states (including HAZ), and the resulting performance when subjected to static and dynamic loads after welding
HORSE	Horse has extensive experience in welding, particularly in laser welding for joining parts subjected to high torque stress, mainly in gear joints. Testing and characterization is part of the know-how of Horse powertrain solutions.	Comprehensive knowledge of the technical feasibility and applicability of FSW to join cast iron to high strength steel, as well as its application to a vehicle differential assembly. Key exploitable results of the project: FSW enables achieving a less operator-dependent joint quality. With FSW, a higher quality product can be offered at the same cost, that can also be delivered in a shorter lead time, which is the most crucial factor. Expected product/service improvements: More reliable products with less weld defects, and subsequent in-situ repairs; decrease of the average product cost.
HIAB	Extensive experience in: - Welding of high strength steel - Designing and manufacturing of loader crane high strength steel component susceptible to very high fatigue loads - Research on materials/welds: fatigue testing, material characterization	Knowledge about the creation of 3D friction stir welds of steels, including dissimilar metal and dissimilar thickness joints, which will allow to implement this joining method into production, providing a cost-effective solution for crane manufacturing. Defect reduction using the automated solid-state FSW process, combined with real-time process control, allowing a reduction of costs. Increased fatigue life of welded crane components due to the solid-state nature of the welding process.

E6	Confidential information and know-how relating to all aspects of synthesis and design of superhard materials for FSW applications; design and manufacturing tools for FSW applications; optimizing process parameters to achieve optimum tool performance in FSW applications. Numerous patent applications and patents relating to superhard materials for FSW applications, tools for FSW applications, and methods of synthesis thereof, and registered designs relating to tools for FSW applications.	Greater knowledge about the durability of FSW tools made up of different materials when applied to the welding of the different materials combinations considered in STWIN. Knowledge about the manufacture of FSW tools for welding high strength steels and steels with large thicknesses. Knowledge about FSW of steel profiles with small radii.
TRICYLON	Expertise in advanced robotics design and manufacturing, with a focus on building high-precision, high-payload, multi-degree-of-freedom robotic systems. Deep understanding of real-time control systems, adaptive robot programming, and advanced motion planning algorithms for industrial applications. Extensive experience in integrating robotics with digital twin technologies to simulate and optimize robotic workflows in manufacturing. Knowledge in modular machine-building principles, enabling scalable and versatile solutions tailored to various industrial use cases.	Knowledge about 3D FSW of steels, which will serve to address new applications. Adaptive robot control system for advanced FSW of 3D complex structures. Real-time data analysis infrastructure for FSW. Potential markets: Automotive, aerospace, construction, …

6 Business modelling approach

Following the establishment of a solid inventory and baseline of the market landscape, adequate and effective business models will need to be elaborated. At this stage, depending on the outcomes of the *Phase A - Technology assessment,* a second prioritization stage might be required to focus the business modelling efforts only on the most promising results and technologies of the project. To ease the development of the business models, several proven methodologies will be applied to help the consortium members not only to characterise and profile the solution they are creating but also to highlight its eventual clear competitive edge in one arena or several at the same time. The different tools that will be employed during the process are described below.

Description of competitors landscape including benchmarking

In the analysis of the competitors included in *Phase A2 - Technology evaluation* phase, the main competitors have been identified and their main characteristics have been described. Based on the outcome of that analysis, in this second stage a deeper analysis will be made focusing only on those direct competitors in the fields of the KERs selected to develop the business plan. Tentative steps to complete this analysis would be:

- Analysis of the products that competitors offer and look at their functionalities and characteristics.
- Analyse whether the competitors have any patent which protects the technology of their products and acts as an entry barrier to the market.
- Benchmark each product's functionalities and characteristics against the features of the partners involved in the exploitation of the KER. This benchmarking will give a view of the position of the partners regarding their main competitors. Besides, it will allow for matching their successes and highlighting their shortcomings, and therefore will help to find ways to improve quality and performance of the proposed solution.

Stakeholder analysis

The stakeholder analysis can be defined as the systematic examination and evaluation of stakeholders in order to prioritise, manage and engage with them effectively.

The first step of the stakeholder analysis is to identify who are the stakeholders. In general, a stakeholder is any group or individual who can affect or is affected by the achievement of the project objectives. To identify the new business stakeholders, the partners will have to think of all the people who are affected by the business, who have influence or power over it, or have an interest in its successful or unsuccessful conclusion.

To streamline the process, several tools can be employed. For instance, the mind mapping tool organises information visually in a diagram (Figure 4). For this purpose, the mind map will be crated around the concept of stakeholders, hence they will be in the centre of the diagram. Associated to it, major potential groups are connected to it, while at the same time other less important concepts may branch out of those.

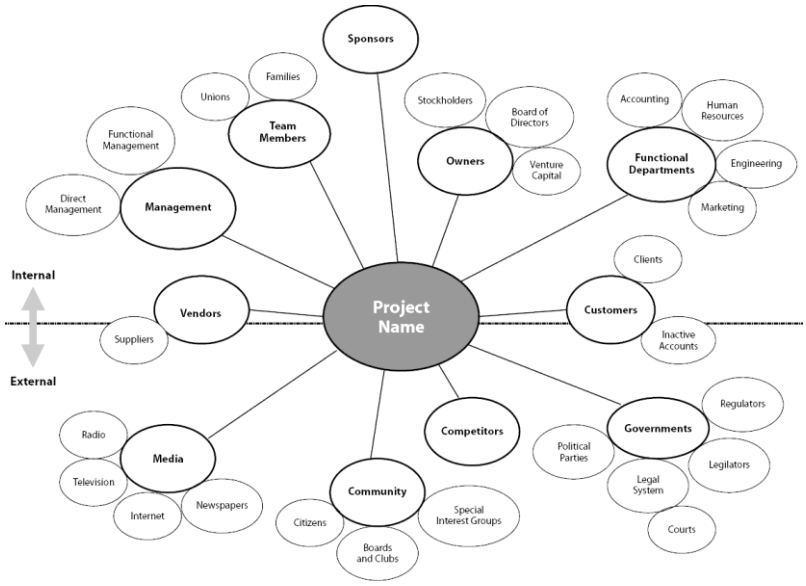


FIGURE 4 STAKEHOLDER ANALYSIS DIAGRAM EXAMPLE. SOURCE: PROJECT MANAGEMENT INSTITUTE (2)

The following step of the stakeholder analysis is to prioritise them (Figure 5). The prioritisation can be made, for instance, using a power/interest grid, in which stakeholders are grouped based on their level of authority (power) and concern (interest). The position of a certain stakeholder on the grid shows the strategy to be taken with them:

- High power, high interest: these stakeholders must be fully engaged and the greatest efforts to satisfy them have to be made.
- High power, low interest: enough work has to be put on them to keep them satisfied, but not so much that they get bored.
- Low power, high interest: the strategy is to keep them adequately informed to ensure that no major issues may arise.
- Low power, low interest: some monitoring is advisable but only moderate efforts should be put on them.

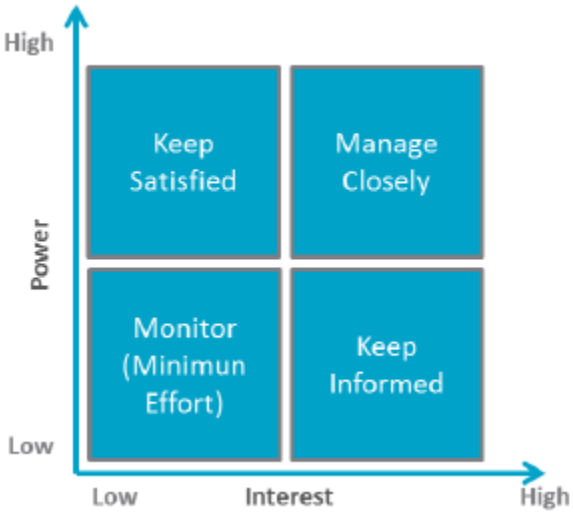


FIGURE 5 PRIORITIZATION OF STAKEHOLDERS

Finally, for each stakeholder, appropriate actions are defined.

PESTEL analysis

PESTEL is an abbreviation for Political, Economic, Social, Technological, Environmental and Legal factors (Figure 6). In broad terms, it is a tool that can be used to analyse and monitor the macro-environmental factors that have an impact on the future exploitation of the project results. The PESTEL analysis result, complemented with some of the information collected in previous steps of the exploitation methodology, will be used to identify mostly threats and weaknesses in a subsequent SWOT analysis

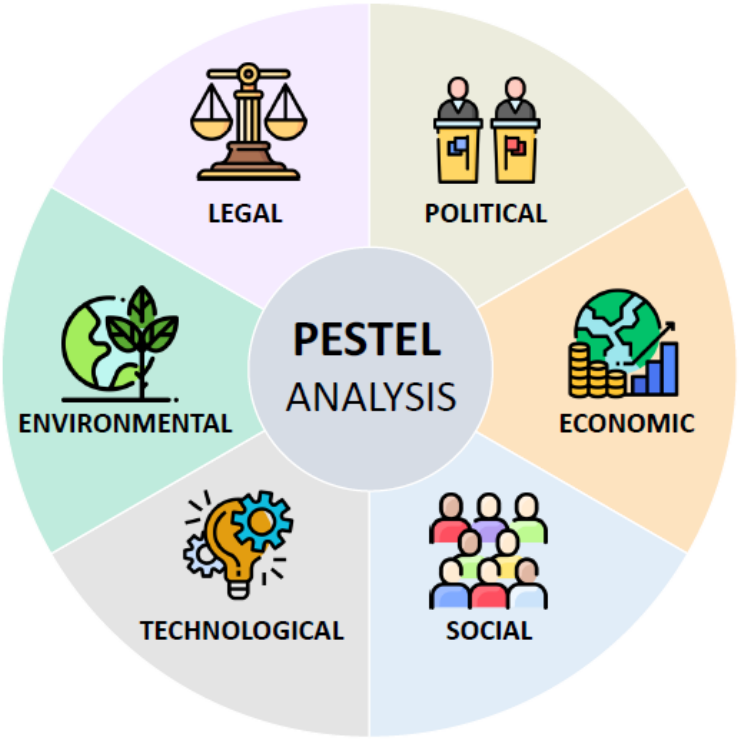


FIGURE 6 PESTEL ANALYSIS FACTORS (3)

SWOT analysis

An analysis of the **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats of each KER will be performed (Figure 7), which dives into more detail on the competitive advantage of the solutions. The analysis will help the consortium members in understanding which part of the offering should be highlighted at which moment and to which market segment.



FIGURE 7 SWOT ANALYSIS (4).

Risk assessment at business level

The first task in the risk analysis process will be the identification of the risks that can put the success of the new business in danger. It is also important to identify the type of each risk. The proposed methodology classifies business risks in four main categories:

- **Strategic risks**: they result directly from operating within a specific industry at a specific time. Shifts in consumer preferences or other emerging technologies can put the new business in danger.
- **Financial risks**: they have to do with how the business handles money. They are associated with the financial structure and transactions of the business.
- **Operational risks**: they result from internal failures, that is to say, the business' internal processes, staff or systems fail unexpectedly.
- **Compliance risks**: they are subject to legislative or bureaucratic rule and regulations, or those associated with best practices for investment purposes.

Participants of each KER evaluated will be asked to write down major risks, probability of risk happening, as well as Feasibility/Success of Intervention. Based on the given information, it is created the Priority Map (Risk grade vs % success of intervention), which is a matrix divided into 4 quadrants: No action, control, action, warning (Figure 8).

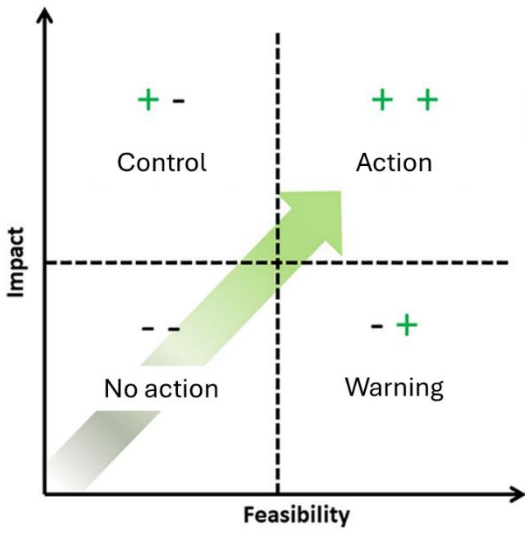


FIGURE 8 RISK PRIORITIZATION MAP EXAMPLE (5)

Value proposition

The value proposition canvas (Figure 9) is a tool that helps to build the business value proposition for customers in a more structured and reflective manner. It is aimed at determining whether what the project delivers is relevant to the customers' needs. A comprehensive value proposition canvas consists of two main blocks: the value proposition, and the customer segment. In the customer segment section, a customer profile is created through the analysis of customer jobs, their pains and their gains. Following and analogous approach, in the value proposition section the products and services offered to the potential customer, their pain relievers and gain creators are described. Both are developed in parallel so that they fit together.

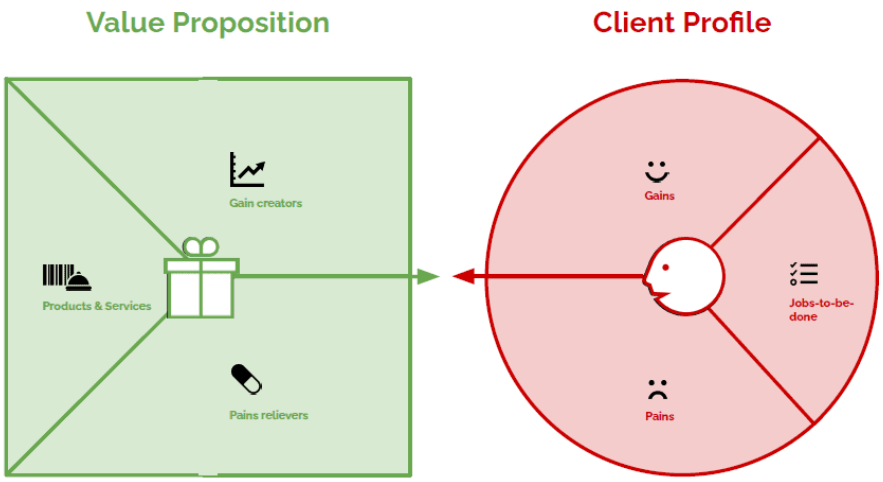


FIGURE 9 VALUE PROPOSITION CANVAS TEMPLATE (6)

Business model canvas

The last activity of the business modelling process is to synthetize all the information into a business model canvas. A traditional business model canvas (Figure 10) contains all characterising information of a business, making it a clear, simple, and compact overview. All partners should complete a business model canvas per KER when the development processes reach a final phase. The business model canvas therefore condenses the main findings of the analysis made in the business modelling stage of the exploitation strategy.

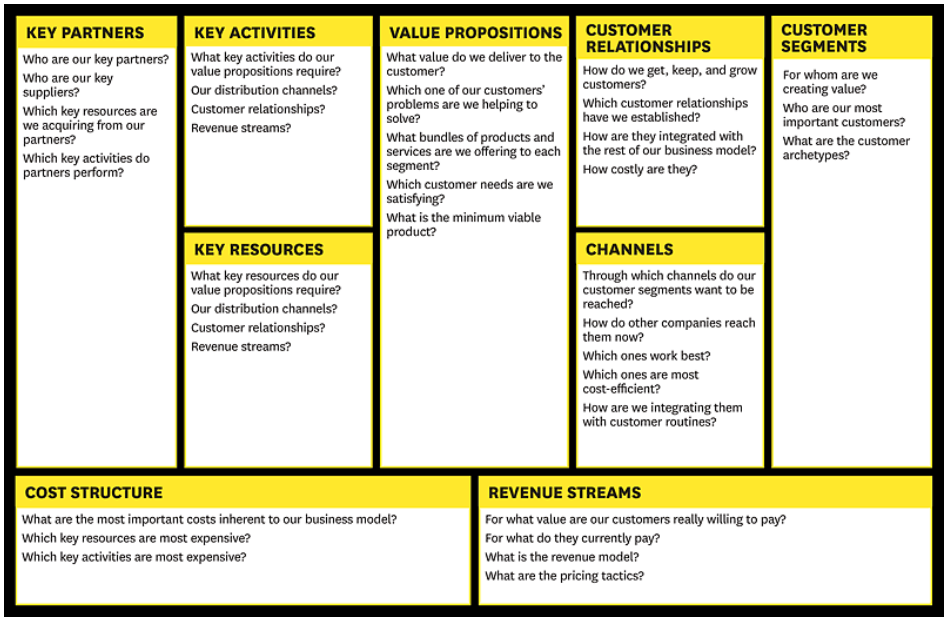


FIGURE 10 BUSINESS MODEL CANVAS TEMPLATE EXAMPLE (7)

7 Plan ahead

In order to ensure the completion of all the previously described activities in due time, the time plan for each one of them and their sequence is shown in Table 3.

TABLE 3 PLAN AHEAD FOR THE COMPLETION OF THE EXPLOITATION STRATEGY

Month	Activity
A – Technology assessment	
M19-M20	IDENTIFICATION OF RESULTS
M21-M22	TECHNOLOGY EVALUATION
M23	PRIORITIZATION
M24	GROUND IDENTIFICATION + COST-BENEFIT MATRIX
M25-M26	PATENTS ANALYSIS
M27	COMPETITOR ANALYSIS + MARKET RESEARCH
M28	IPR UPDATES
M29	STANDARDIZATION POTENTIAL ASSESSMENT
M30	RISK ASSESSMENT
B – BUSINESS PLAN	
M31-M33	BUSINESS MODELLING TOOLS
M34	BUSINESS MODELLING CANVAS
C – COMPETITIVE INTELLIGENCE ACTIVITIES	
M19-M34	DEVELOPMENT OF ACTIVITIES
M35-M36	REPORTING

8 Conclusions

The described exploitation strategy ensures:

- Maximum innovative and social impact
- Accountability of the project partners
- Transparency in relation to the use of project results
- An increase success rate by proactively identifying different potential exploitation ways
- Fulfilment of grant agreement

Also, an update on the individual exploitation plans expected from the partners has been provided.

References

1. Azkarate A et al. FOCUS H2020 project. D2.2 - Methodology for industrial exploitation & take-up. 2016;
2. Smith L et al. Stakeholder analysis [Internet]. Available from: https://www.pmi.org/learning/library/stakeholder-analysis-pivotal-practice-projects-8905
3. Segura E, Belmonte LM, Morales R, Somolinos JA. A Strategic Analysis of Photovoltaic Energy Projects: The Case Study of Spain. Sustain. 2023;15(16):1–37.
4. Peterdy K. SWOT analysis [Internet]. Available from: https://corporatefinanceinstitute.com/resources/management/swot-analysis/
5. Njuguna B, Fletcher SL, Akwanalo C, Asante KP, Baumann A, Brown A, et al. Proactive prevention: Act now to disrupt the impending non-communicable disease crisis in low-burden populations. PLoS One [Internet]. 2020;15(12 December):1–12. Available from: http://dx.doi.org/10.1371/journal.pone.0243004
6. Pereira D. ¿Qué es el Canvas de propuesta de valor? (in Spanish) [Internet]. Available from: https://businessmodelanalyst.com/es/value-proposition-canvas/
7. Osterwalder A. A better way to think about your business model [Internet]. Available from: https://hbr.org/2013/05/a-better-way-to-think-about-yo