D1.1 – Project Vision Guide Document

WP1 – NEED: Industrial Scenarios and Requirements Analysis

Co-funded by the European Union

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ABSTRACT	This document aims to define a consensual project vision, establish the state of art in terms of technologies for quality in manufacturing. Deliverable D1.1 consists of a guide document, the 'Project Vision Guide', which will act as a reference for the project and will be used by all partners to stay focused on the main ideas and goals of the project. The document will also be used internally to keep the performed tasks in synchronisation with the overall idea of the project. It may also be used by the partners as a source for documents, deliverables and presentations to third parties to get an early overview of the project. In addition, this document will include an initial risk table, upgraded from the DoA, which itemises general inherent risks of innovation activities.		

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS/ACRONYMS

AC	Adaptive Controller
AD	Anomaly Detector
AI	Artificial Intelligence
API	Application Programming Interface
CAD	Computer Aided Design
CAE	Computer Aided Engineering
CAM	Computer Aided Manufacturing
CAx	CA Addon
CE	Condition Evaluator
CE	Circular Economy
CEN	European Committee for Standardisation
CNC	Computerised Numerical Control
CV	Curriculum Vitae
CWA	CEN Workshop Agreement
DIS	Disassembler
DO	Delivery Optimiser
DoA	Description of Action
EBM	Extrusion Blow Moulding machine
EC	European Commission
EU	European Union
FO	Fabrication Optimiser
FTO	Freedom To Operate
HMI	Human Machine Interface
ICT	Information Communication Technologies
IEDS	Industrial Equipment Design Suite
IERS	Industrial Equipment Repair-Reuse-Recycle Suite
IEUS	Industrial Equipment Use Suite
IA	Innovation Action
IP	Internet Protocol
IP	Intellectual Property

IPR	Intellectual Property Rights
ISO	International Standardisation Organisation
KER	Key Exploitable Result
KPI	Key Performance Indicator
LC	Life Cycle
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
M	Machine Passport
MC	Machine Calibrator
MDG	Machine synthetic Data Generator
MDO	Machine Design Optimiser
MES	Manufacturing Execution System
MS	Milestones
MT	Machine Tools
OEE	Overall Equipment Effectiveness
OER	Other Exploitable Results
OPC	Open Platform Communication
OPC-UA	Open Platform Communication United Architecture
PCB	Printed Circuit Boards
PLC	Programmable Logic Controller
PM	Prescriptive Maintenance
PO	Procurement Optimiser
QA	Quality Assurance
S-LCA	Social Life Cycle Assessment
SME	Small-Medium Enterprise
SR	Smart Retrofitter
SW	Software
TRL	Technology Readiness Level
UI	User Interface
WP	Work Package
ZMDP	Zero Defect Manufacturing Platform

Executive summary

The AIDEAS project aims to develop AI technologies for supporting the entire life cycle of industrial equipment (design, manufacturing, use and repair/reuse/recycle) as a strategic instrument to improve sustainability, agility and resilience of the European machinery manufacturing companies.

AIDEAS Project will create 4 AIDEAS Suites, namely, AIDEAS Industrial Equipment Design Suite, AIDEAS Industrial Equipment Manufacturing Suite, AIDEAS Industrial Equipment Use Suite, AIDEAS Industrial Equipment Repair-Reuse-Recycle Suite, and 1 AIDEAS Machine Passport as Key Exploitable Results (KERs).

The 4 AIDEAS Suites are composed by 15 AIDEAS Solutions, which aim to improve a set of Key Performance Indicators (KPIs), linked with the AIDEAS specific objectives.

AIDEAS Solutions will be demonstrated in 4 industrial pilots. All are industrial equipment manufacturers, they belong to different sectors, so different problems will be addressed. Moreover, all pilots address different stages of the product life cycle, starting from the design, through the manufacturing, use and finalising with its repair, reuse and recycle.

WP1 aims at defining a consensual project vision, establishing the state of art in terms of technologies for industrial equipment design, manufacturing, use and repair-reuse-recycle, setting the specifications driving the creation of AIDEAS Solutions and Key Performance Indicators. The following specific objectives are targeted in WP1:

- O1.1 To synchronise the project vision and provide an overview to the target audience.
- O1.2 To perform a multi-dimensional assessment of current technologies for industrial equipment design, manufacturing, use, and repair-reuse-recycle, and establish benchmarks.
- O1.3 To set-up the most suitable Key Performance Indicators for the project use case scenarios.
- O1.4 To define a clear set of specifications driving the creation of the demonstration cases of the AIDEAS Solutions.

Task 1.1 is responsible for providing a balanced guide document as a deliverable, the Project Vision Guide (D1.1) which will act as a reference for the project and will be used by all partners to stay focused on the main ideas and goals of the project. The document will also be used internally to keep the performed tasks in synchronisation with the overall idea of the project. It may also be used by the partners as a source for documents, deliverables and presentations to third parties to get an early overview of the project. In addition, this document includes an initial risk table, upgraded from the DoA, which itemises general inherent risks of innovation activities.

Document structure

Section 1 Introduction: Introduces the deliverable and its content.

Section 2 Elevator Pitch: Executive description of the AIDEAS Project and its results that explains the concept in a way such that any reader or listener can understand it in a short period of time.

Section 3 High Level Vision: Positions the project in terms of business, research and technological objectives, and use case scenarios.

Section 4 Positioning: Characterises the project in terms of context (business opportunities, stakeholders, post-project commercialisation) and addresses the contribution of AIDEAS results.

Section 5 Project Results: Summarises the AIDEAS Solutions and standardisation activities.

Section 6 Milestones and deliverables: Provides both tables with the project milestones and the project deliverables.

Section 7 Risks: Presents the critical implementation risks and mitigation actions of the AIDEAS project.

Section 8 Conclusions: Summarises the Project Vision Document.

1 Introduction

Machinery industry in Europe is a basis for employment, growth and wealth, with around 3.2 million people employed. Industrial equipment is considered a key enabler for industrial development and the EU has a historically strategic position in this sector. However, it lives from a technological edge in a very competitive landscape. Hereby, it is crucial to provide all stakeholders of the EU with AI technologies that guarantee a resilient design, deployment and reuse of industrial equipment for an increased global competitiveness and a reinforcement of its industrial strategic autonomy and resiliency.

AIDEAS will develop AI technologies for supporting the entire lifecycle (design, manufacturing, use, and repair/reuse/recycle) of industrial equipment as a strategic instrument to improve sustainability, agility and resilience of the European machinery manufacturing companies.

AIDEAS will deploy 4 integrated Suites:

1) Design: AI technologies, integrated with CAD/CAM/CAE systems, for optimising the design of industrial equipment structural components, mechanisms and control components;
2) Manufacturing: AI technologies for industrial equipment purchased components selection and procurement, manufactured parts processes optimisation, operations sequencing, quality control and customisation;
3) Use: AI technologies with added value for the industrial equipment user, providing enhanced support for installation and initial calibration, production, quality assurance and predictive maintenance for working on optimal conditions;
4) Repair-Reuse-Recycle: AI technologies for extending the useful life of machines through prescriptive maintenance (repair), facilitating a second life for machines through a smart retrofitting (reuse) and identification of the most sustainable end-of-life (recycle).

The AIDEAS Solutions will be demonstrated in 4 Pilots of machinery manufacturers that provide industrial equipment to different industrial sectors: metal, stone, plastic and food.

The AIDEAS European consortium entails four Industrial partners: PAMA (metal sector), D2TECH (stone sector), BBM (plastic sector) and MULTISCAN (food sector), technical partners such as FBA, UNINOVA, UNIVPM, TAU, and UPV that will support industries with the development of new business models and ITI and CERTH that will support them with a continuous market watch.

Additionally, ITI, TAU, and IKERLAN will provide expertise on human rights and ethical aspects (incl. aspects such as trustworthiness of industrial IoT applications), while CERTH and ITI will provide expertise on legal aspects.

UPV, UNIVPM and UNINOVA will deliver material and services for user training. Last but not least, the partners leading the exploitation activities (FBA, CESI, IANUS and XLAB), together with the industrial partners will address the marketing aspects of the AIDEAS Solutions.

2 Elevator Pitch

The AIDEAS project proposes the development of 4 Suites composed by 15 Solutions, which will allow benefiting from AI technologies applied to the entire industrial equipment life cycle (Figure 1):

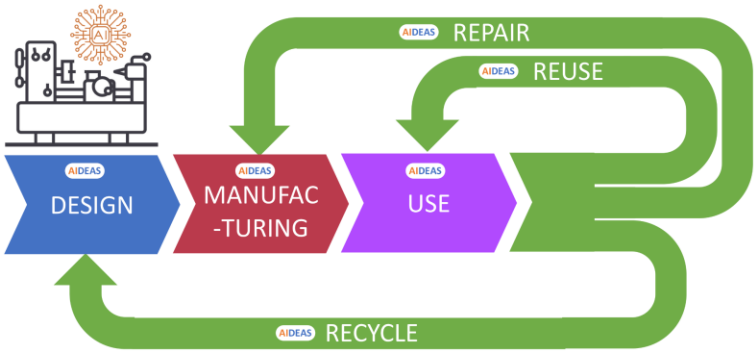

Figure 1. AIDEAS life cycle.

- DESIGN: to optimise the industrial equipment design with AI-assisted tools that generate product design suggestions for the optimal construction of machines, allowing companies to reduce waste and to increase the ability to respond to the changing needs of customers (resilience).
- MANUFACTURING: to increase agility by operating in a predictable manner, even in the face of extreme complexity, with product delivery schedules predicted much more accurately to get much faster to market.
- USE: to guarantee the proper industrial equipment installation and initial calibration, the fast machinery condition evaluation and anomaly detection combined with the adaptive control of industrial equipment, and to support the product quality guarantee and zero defects.
- REPAIR-REUSE-RECYCLE: to support a circular production by AI-based solutions for repairing, reusing and recycling industrial equipment, achieving optimal productivity, recycling vs. down cycling, and optimising residual value of materials.

The 15 AIDEAS solutions per Suite (Figure 2), are listed below:

AIDEAS Industrial Equipment Design Suite	AIDEAS Industrial Equipment Manufacturing Suite	AIDEAS Industrial Equipment Use Suite	AIDEAS Industrial Equipment Repair-Reuse-Recycle Suite
AIDEAS Machine Design Optimiser	AIDEAS Procurement Optimiser	AIDEAS Machine Calibrator	AIDEAS Prescriptive Maintenance
AIDEAS Machine Synthetic Data Generator	AIDEAS Fabrication Optimiser	AIDEAS Condition Evaluator	AIDEAS Smart Retrofitter
AIDEAS CAx Addon	AIDEAS Delivery Optimiser	AIDEAS Anomaly Detector	AIDEAS LCC/LCA/S-LCA
		AIDEAS Adaptive Controller	AIDEAS Disassembler
		AIDEAS Quality Assurance	
AIDEAS Machine Passport			

Figure 2. AIDEAS Suites.

- **AIDEAS Industrial Equipment Design Suite** (AI^{IEDS}):

- AIDEAS Machine Design Optimiser (AI^{MDO}): Toolkit to assist designers to optimally define the key design parameters in multiphysical systems, enhancing machine performance as required for each scenario, through AI.
- AIDEAS Machine Synthetic Data Generator (AI^{MDG}): Toolkit for synthesising large high-quality datasets by simulations for the analysis of the machine design and for the training of the optimisation algorithms that will propose optimal design parameters.
- AIDEAS CAx Addon (AI^{CAx}): Set of APIs and UIs supporting the integration of AI-assisted optimisation modules into CAx systems.

- **AIDEAS Industrial Equipment Manufacturing Suite** (AI^{IEMS}):
  - AIDEAS Procurement Optimiser (AI^{PO}): Toolkit for optimising the inventory and purchase of materials and components that are required to build a machine and meet customer delivery dates using AI.
  - AIDEAS Fabrication Optimiser (AI^{FO}): Toolkit for optimising production scheduling and resource allocation by predicting production and set-up times, operations dependencies, etc. allowing a near real time response to environment changes like machine breakdowns, last minute customer orders and raw materials delays, through AI.
  - AIDEAS Delivery Optimiser (AI^{DO}): AI-based toolkit that is capable of optimising the storage and delivery of products. This optimisation will target storage space, storage conditions and product transportation. Additionally, this optimiser will provide optimisation for logistics scheduling and planning.
- **AIDEAS Industrial Equipment Use Suite** (AI^{IEUS}):
  - AIDEAS Machine Calibrator (AI^{MC}): Toolkit for the fast calibration of industrial equipment when installed for the first time in a factory or when a re-calibration is needed. It uses AI techniques for providing the most well-suited calibration parameters.
  - AIDEAS Condition Evaluator (AI^{CE}): Toolkit for determining the condition of the machine as a whole or of some of its components when it is in working conditions in the factory where it is being used.
  - AIDEAS Anomaly Detector (AI^{AD}): Toolkit that will allow detecting anomalies at component-level or of the machine as a whole when it is in working conditions in the factory where it is being used.
  - AIDEAS Adaptive Controller (AI^{AC}): Toolkit to train models with measurement data and then train machine controllers with said models to accommodate the machine condition and requirements.
  - AIDEAS Quality Assurance (AI^{QA}): Toolkit comprising a set of AI-enabled features for manufactured product quality monitoring.
- **AIDEAS Industrial Equipment Repair-Reuse-Recycle Suite** (AI^{IERS}):
  - AIDEAS Prescriptive Maintenance (AI^{PM}): Toolkit for predicting remaining useful life and identifying maintenance requirements with the target of extending the overall machine remaining life.
  - AIDEAS Smart Retrofitter (AI^{SR}): Toolkit for smart retrofitting old machine tools to give them a second life by improving working conditions and product quality, developing

a communication system and collaboration, enhancing productivity, efficiency, flexibility, and agility.

- AIDEAS LCC/LCA/S-LCA (AI^{LC}): Toolkit that combines AI and Life Cycle methodologies (LCC, LCA, S-LCA) for identifying the best machine end-of-life by devising a multi-objective optimisation strategy to strike a balance between economic, social and environmental benefits.
- AIDEAS Disassembler (AI^{DIS}): AI based toolkit for modelling the disassembly/recycle processes to help streamline the infrastructure needed to circulate materials focusing on the ability for AI algorithms to recognise and identify objects using cameras and other sensors.

- **AIDEAS Machine Passport** (AI^{M}): Smart platform for multi-source large-scale data acquisition, management and sharing among different devices regarding:
  - Design phase of the industrial equipment, providing suggestions for the optimal construction of industrial machinery.
  - Manufacturing phase of the industrial equipment, supporting the manufacturing parties in the supply chain (supplier, manufacturer and customer).
  - Use phase of the industrial equipment, allowing CNC optimal calibration parameters, data concerning the stable functionality of the machine components along with those concerning the manufactured product quality monitoring.
  - Repair-Reuse-Recycle phase of the industrial equipment, exchanging data between the end-of-life parties in the supply chain (consumers, repair shops and waste management companies).

3 High Level Vision

The European Union has a historically strategic position in the industrial equipment sector, which is considered a key enabler for industrial development and is a basis for employment, growth and wealth. The EU machinery manufacturers live from a technological edge that is being feverously challenged due to the astonishing growth of China during the 21st century and its industrial strategic plans such as “Made in China 2025” and “Intelligent Machine Tool” with the help of the new generation of AI technologies. It is needed that the EU take an active approach rather than reactive to keep its industrial equipment sector at the state-of-the-art playground, keeping its dominant position in the market, with the incorporation of AI technologies to the machinery manufacturing that guarantee a resilient design, deployment and reuse of industrial equipment for an increased global competitiveness and a reinforce of its industrial and strategic autonomy.

3.1 Overall Concept of AIDEAS

The overall concept of AIDEAS is summarised in the 9 specific objectives to create the project results and 26 Key Performance Indicators (Table 1), linked with the AIDEAS Solutions and the specific objectives:

O1: To develop and share among the different consortium partners and other stakeholders the AIDEAS Project Vision, establish the state of the art in terms of technologies for industrial equipment design, manufacturing use and repair/reuse/recycle, and to set the requirements driving the creation of AIDEAS Solutions.

O2: To design the AIDEAS Framework and deliver the Reference Architecture for smart manufacturing and devised using multiple perspectives, related to business, usage, functional and implementation viewpoints.

O3: To build the AIDEAS Industrial Equipment Design Suite, providing AI-assisted optimisation modules that generate design proposals for the construction of industrial equipment.

O4: To build the AIDEAS Industrial Equipment Manufacturing Suite, a set of AI technologies for the manufacturing phase of industrial equipment with the objective of achieving a high level of agility and sustainability between the manufacturing parties.

O5: To build the AIDEAS Industrial Equipment Use Suite, a set of AI technologies for the use of industrial equipment to be exploited by the companies that buy the machines.

O6: To build the AIDEAS Industrial Equipment Repair-Reuse-Recycle Suite, a set of AI technologies for the repair/reuse/recycle of industrial equipment to be used by the companies that perform such operations.

O7: To test and validate the AIDEAS Solutions in 4 use cases, machinery manufacturers covering different industrial sectors (metal, stone, plastic and food).

O8: To disseminate the AIDEAS Solutions, providing outreach of the project activity and results, paving the way for a broad adoption of AIDEAS Solutions in the industry. To create or contribute to standards, compliant with existent and evolving ICT standards, facilitating regulation and

certification. To facilitate technology uptake and long-term adoption of the AIDEAS Solutions by the machinery manufacturing industry.

O9: To properly manage the project for guaranteeing that the project objectives are met by ensuring the successful completion of the project on-resource, on-quality and on time.

KPI	Key Performance Indicator	Codes	OBJ
KPI1	Increase of efficiency of machinery manufacturing resources allocation	AI^{FO}	**O4**
KPI2	Increase of efficiency of secondary material usage in machinery manufacturing	AI^{FO}	**O4**
KPI3	Increase of first pass yield in machinery manufacturing	AI^{FO}	**O4**
KPI4	Increase of machine OEE	AI^{AC}	**O6**
KPI5	Increase of machine operations accuracy	AI^{MDO} AI^{MDG}	**O3**
KPI6	Increase of machine operations efficiency	AI^{MDO} AI^{MDG}	**O3**
KPI7	Increase of machine performance	AI^{CE}	**O5**
KPI8	Increase of machine useful life	AI^{PM}	**O6**
KPI9	Increase of warehouse available space in machinery manufacturing	AI^{DO}	**O4**
KPI10	Reduction in "time-to-delivery" to the customer of the machine	AI^{MDO} AI^{CAx}	**O3**
KPI11	Reduction of design cycle times	AI^{CAx} AI^{MDO}	**O3**
KPI12	Reduction of energy consumption	AI^{AD} AI^{AC}	**O5**
KPI13	Reduction of environmental and social impact connected to the machine end-of-life	AI^{LC} AI^{SR}	**O6**
KPI14	Reduction of installation time of a new machine	AI^{MC}	**O5**
KPI15	Reduction of machine components ending up in landfill	AI^{SR}	**O6**
KPI16	Reduction of machine end-of-life costs and environmental impact	AI^{LC}	**O6**
KPI17	Reduction of machine maintenance costs	AI^{PM}	**O6**
KPI18	Reduction of machine recycle time and cost	AI^{DIS} AI^{LC}	**O6**
KPI19	Reduction of machinery manufacturing downtime due to material shortage	AI^{PO}	**O4**
KPI20	Reduction of machinery storage and transportation loss ratio	AI^{DO}	**O4**
KPI21	Reduction of production loss ratio in machinery manufacturing	AI^{PO} AI^{FO}	**O4**
KPI22	Reduction of scrap-to-product ratio in machinery manufacturing	AI^{PO} AI^{FO}	**O4**
KPI23	Reduction of scraps, waste and rejected goods ensuring product quality	AI^{AD} AI^{QA}	**O5**
KPI24	Reduction of structural masses of machines and use of materials	AI^{MDO}	**O3**
KPI25	Reduction of time and skills required to calibrate the machine	AI^{MC}	**O5**
KPI26	Reduction time of machinery manufacturing process	AI^{FO}	**O4**

Table 1. AIDEAS Key Performance Indicators

3.2 Realising the AIDEAS Concept

The AIDEAS project implementation is arranged in 9 work packages and will operate over 36 months:

- **WP1** (NEED: Industrial Scenarios and Requirements Analysis) will establish the foundation for the project combining the project vision with the final users' requirements.
- **WP2** (DESIGN: AIDEAS Framework Design) will provide a holistic design of the AIDEAS project solutions, based on system requirements.
- **WP3** (BUILD: AIDEAS 4 Industrial Equipment Design) will be in charge of providing AI technologies for generating enhanced design proposals for the construction of industrial equipment.
- **WP4** (BUILD: AIDEAS 4 Industrial Equipment Manufacturing) will develop AI technologies for the manufacturing stage of industrial equipment for achieving a high level of agility and sustainability between the manufacturing parties.
- **WP5** (BUILD: AIDEAS 4 Industrial Equipment Use) will develop AI technologies for the optimal use of industrial equipment, providing added value to the companies that buy the machines.
- **WP6** (BUILD: AIDEAS 4 Industrial Equipment Repair-Reuse-Recycle) will develop AI technologies for the repair and/or reuse and/or recycle of industrial equipment to be used by the companies that perform such operations.
- **WP7** (EVALUATE: Piloting and Demonstrating) will execute the AIDEAS Pilots setting their own implementation plan including the industrial scenario definition, activities to be done, activities schedule as well as the KPIs measurement and validation criteria.
- **WP8** (IMPACT: Dissemination, Exploitation and Standardisation) will irrigate the project community for a wider sharing of information, concepts and techniques and foster externally the achieved results as well as ensuring the outside feeds "in" through workshops, clustering, and standardisation activities and will define the Key Exploitable Results, develop an Exploitation Strategy and Plan perform market analysis, investigate FTO issues and will define new IP.
- **WP9** (MANAGE: Administrative and Technical Project Management) will be focused on the coordination of the Project actions to guarantee that the project fulfils the expected quality within the planned time and costs.

Figure 3 shows the interdependencies among the different AIDEAS work packages.

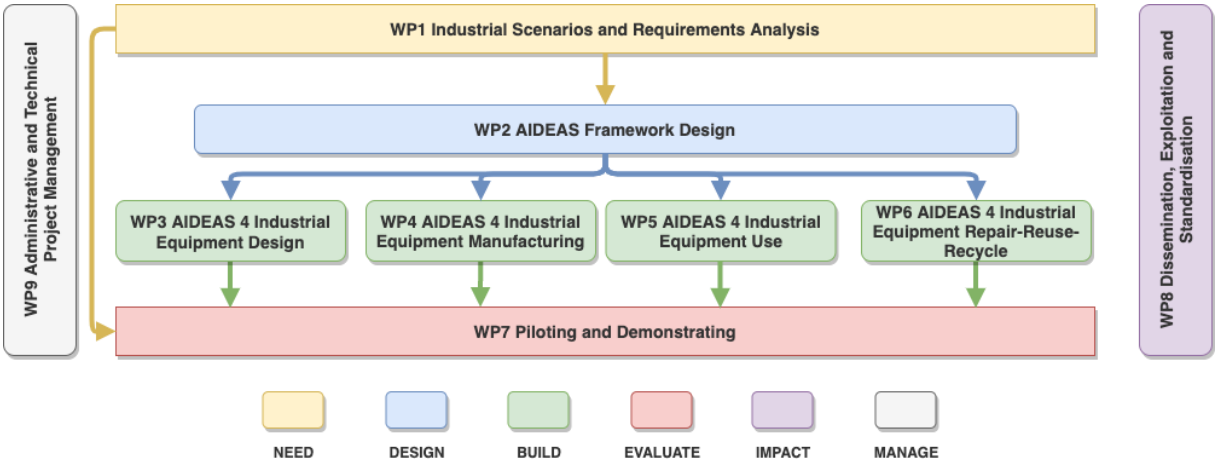

Figure 3. Interdependencies among the different AIDEAS work packages.

The AIDEAS project will adopt a product life cycle-inspired implementation (WP3-WP6). As the project targets Innovation Actions (IA) outcomes, the main aim is utilising and reusing available applications and technologies in building the AIDEAS Solutions.

The overall methodology can be summarised in 5 aspects as follows:

- **Project Management**: This methodology will be defined, promoted, and monitored by WP9, to ensure that all project activities are carried out on time and with the required level of quality and resources that guarantees the success of the project. This methodology also covers aspects of the trustworthy framework for data management, which addresses issues and regulations regarding legal, data rights, data security and IPRs.
- **Industry Scenarios Requirements**: This methodology relates to the high-level industry scenarios requirements collection activities to be done in WP1. It will evaluate the current technologies for the development of the AIDEAS Solutions and define the overall high-level scenarios of the AIDEAS applications, validation scenarios and KPIs. Relevant indicators and metrics will be used to evaluate the results of the Pilots.
- **Software Development**: This methodology will utilise a holistic approach used for the design of the AIDEAS Framework in WP2 by describing the viewpoints related to business, usage, functional and implementation, as the basis for the software development. This approach will be applied to WP3, WP4, WP5 and WP6 software development activities. The methodology adopted is a combination of a waterfall during the first project phases and agile in the development-oriented ones – i.e., hybrid. During the agile phases, a sprint and scrum-based approach will be taken which maximises both the engagement of, and delivery to, the users and thus the representation and delivery of needed vs nice to have.
- **Demonstration**: This methodology, used in WP7, will be structured in four main steps: 1) making the detailed definition and planning of the industrial case-studies of each pilot; 2) establishing the industrial scenarios, this implies having a clear overview of the industrial sector of the pilot's cases and translating it into common constraints and criteria; 3) implementation of the specific AIDEAS Solutions for each pilot; 4) validating AIDEAS features and collecting feedback for improving the AIDEAS Solutions.
- **Dissemination and Exploitation**: The dissemination part (WP8) of this methodology will

promote the spreading of knowledge through different channels to establish awareness and commitment from the numerous different project partners and the industrial communities gravitating around the AIDEAS project and its outcomes. The exploitation part (WP8) of the methodology will be devoted towards preparing an exploitation plan for AIDEAS Solutions ensuring that all relevant stakeholders are involved and have reached an agreement regarding IP rights.

3.3 Scenarios

This section identifies the 4 industrial scenarios in which the AIDEAS Solutions will be demonstrated. Being all of them industrial equipment manufacturers, they belong to different sectors, so different problems will be handled. For each Pilot, the context and situations before and after the use of AIDEAS Solutions are summarised, along with an estimate of the improvement in the KPIs listed in Table 1.

3.3.1 Pilot 1: PAMA SpA - AI for Machining Centres (metal sector)

Context: PAMA SpA is a worldwide manufacturer of boring-milling machines and machining centres and is nowadays leader among large machine tools manufacturers for the Energy, Aerospace and Machinery sectors. All main structures are machined in-house, using PAMA boring-milling machines and machining centres. Quality control is carried out at the various machining stages. PAMA currently collects relevant process data and sensor signals from its machines (located at company shopfloors and at customers sites) and stores them in a centralised data lake. The company is interested in integrating AI and other technologies that could support the management and integration of design, manufacturing, customer use, and reuse of its equipment. Their motivation is to position themselves as a circular-enabled manufacturer and provide added-value with respect to their competitors.

Figure 4. PAMA SpA boring-milling machine.

Before AIDEAS: The current practices in the different stages of the product life cycle are described below:

- DESIGN phase: Performance of precision machine tools and manufacturing equipment are currently evaluated and optimised within the early design stage through advanced multidisciplinary CAE simulation tools. This often requires a very large amount of time for a proper product modelling, and often some machine performance is not correctly evaluated; this in turn will slow down the design loop before converging to an optimal design solution.

- MANUFACTURING phase: Production of parts is done internally or through external suppliers. Manufacturing errors are recorded by the operators (that inform the design department) and sometimes (not very often) stored in PCs (legacy data). No historical tracking of design/production errors is done and therefore no knowledge extraction from events is performed.
- USE phase: Geometric and especially thermal errors (due to extended usage of the machine that causes heat generation at the moving elements and this heat causes expansion of the various structural elements of the machine itself), constitute a significant portion of the total error in a machine tool. Machine Tools' (MT) users of course implement some strategies, more or less effective, to compensate for such errors. However, such strategies are generally tailored to a specific application scenario and suffer the changing of machine configuration, especially in the case of renovation or/retrofitting at end of first life (EO1L).
- REPAIR/REUSE/RECYCLE phase: Repair is implemented on the basis of run-to failure strategies (and preventive maintenance tasks are scheduled on the basis of best maintaining practice for a specific component / group / equipment). In case of sudden (unexpected) failure collateral damages can occur that cause an increase of maintenance and operative (loss of production) cost. Moreover Reuse of a machine tool is not yet a common practice since there is no deep knowledge regarding the actual 'health' state of machine parts/components, at the end of life, and then no rationale behind the sustainable extension of the life of the overall machine.

After AIDEAS: PAMA will exploit the potential of the AIDEAS AI technologies to improve sustainability quality and resilience of its products to foster AI-based digital transformation within the manufacturing sectors. PAMA aims to use the AIDEAS Machine Passport to conform large datasets consisting of timestamped signals sensors and CNC/PLC data collected during the use phase (primarily) as well as other phases in the life cycle. Unified standard service modelling techniques will ensure the aforementioned data compatibility, interoperability, consistency and quality. These data sets will be used: i) to improve the performance of the machine learning models that predict machining process anomalies/deviations with respect to nominal conditions, and ii) to improve designs, fabrication and repair/reuse/recycle of the equipment. Expected contributions of AIDEAS AI Solutions to the different stages of the product life cycle are described below:

- DESIGN phase: AI-based (data-driven) prediction of products (machine tools) performance within early design stage. Such a prediction will enable smarter and faster optimisation, reduce product development time, and boost digital transformation of industry. The challenge is represented by a robust and confident prediction of new designed machine performance through an AI data-driven approach that parses design space variables (e.g. size, strokes, materials, system architecture, power, etc.). For this purpose, the AIDEAS Machine Design Optimiser solution will be exploited and validated. The AI model is trained with a consistent (labelled) dataset of historical results obtained by correlation of design parameters values and machine performances (e.g. precision, chip removal capacity, cycle time, Kv, Jerk…) actually obtained in real field applications. [KPI11 -30%] [KPI24 -20%].
- MANUFACTURING phase: Retrofit the design with the outcomes of the manufacturing process, to optimise the future designs. In particular exploiting AI tools to parse historical data (related to tracking of production problems) to find some insights, in particular to

correlate measuring results of single produced part (parallelism, straightness, planarity, perpendicularity, etc.) to the overall accuracy of final assembly. For this purpose, the AIDEAS Fabrication Optimiser solution will be exploited and validated. The AI model is trained with a consistent (labelled) data set obtained by correlation of outcomes of single part measures with part assembly ones. [KPI3+15%] [KP26 -10%].

- USE phase: Exploiting AI to predict (and then compensate through an adaptive control) the geometric and thermal errors of machine/equipment during machining/production of parts. The prediction model is based on input of process variables (e.g. drives currents, absorbed powers, temperature, etc.) as well as design & performance variables. For this purpose, the AIDEAS Condition Evaluator and the AIDEAS Anomaly Detector solution will be exploited and validated. Predict energy consumptions and correlate to expected errors as well as generate clusters of optimal working conditions (minimisation of errors and energy). Process parameters responsible for any deviation with respect to optimal condition will be then automatically re-tuned through AIDEAS Adaptive Controller solution (via CNC). [KPI14 -25%] [KPI23 -15%].
- REPAIR/REUSE/RECYCLE phase: At end of 1st life of the machine, exploit AI-tool to assess how the machine has performed during its life and then identifying which parts (including pieces of SW) could still be reused in other machines, identify smart retrofitting strategies (optimal remanufacturing/renovation approaches that take into consideration energy consumption, safety level, maintainability, productivity, and increased technological level) and estimating operative cost and effective maintenance plan for the second lifetime period. For this purpose, the AIDEAS Smart Retrofitter and AIDEAS LCC/LCA/S-LCA and the AIDEAS Disassembler solutions will be exploited and validated. [KPI4 +15%] [KPI8 +20%].

3.3.2 Pilot 2: D2 Technology - AI for Cutting Machines (stone sector)

Context: D2 Technology is a Portuguese SME company, founded at the beginning of this millennium that has been evolving the stone industry throughout its existence. It is a high technology company in the stone sector and today it is especially characterised by the design and production of various innovative CNC equipment for the stone sector. D2TECH has branches in Brazil, Germany and USA, as well as distributors in other countries. D2TECH has defined a set of interventions that will allow achieve a set of strategic objectives in the medium and long term, that coherently contribute to the mission and vision outlined: increase turnover by at least 40%, increase turnover exports up to 55%, diversify export markets by at least three more countries, participate in international events/fairs in order to enhance the corporate image and diversify the strategy of marketing of the company.

Figure 5. D2TECH, CNC equipment for stone sector.

Before AIDEAS: Handling complexity in the configuration of natural stone patterns is a daily challenge addressed by D2TECH. Due to exclusive patterns and unique finishing, the final aspect of each surface where natural stone is applied is highly dependent on the raw material physical behaviour and the transformation process stages. The current practices in the different stages of the product life cycle are described below:

- DESIGN phase: Currently the design and conceptualisation of new CNC machines, but also the improvement of current models, is performed by engineers and technicians with the support of CAD/CAM software tools (ex. SolidWorks, DDX - EasyStone, Heglmeier). Such tools don't provide the knowledge about the behaviour of such machines within its usage, regarding common anomalies or most deteriorated parts. There's no kind of feedback mechanisms that could support designers in the conceptualisation of new CNC machines.
- MANUFACTURING phase: A CNC machine is a finely crafted tool that needs correct alignment to function at its best. When a machine is not properly calibrated, the end product may have deformities, or the dimensions may be wrong. Even worse, a machine that is perpetually running out of alignment will have a shorter lifespan. Calibrating a CNC machine is typically performed by humans adopting a trial and test approach, which is a time-consuming task and can lead sometimes to different types of problems.
- USE phase: In order to better plan the cutting process, companies need to know on a continuous basis information about the stone in a raw shape (technical data about composition of the stone). Companies aim to start earlier planning and adjust machine settings for cutting, polishing and finishing processes. With respect to the production of the finished product, one of the main barriers is to check the stone properties (quality, dimensions, patterns, among others) since it is a complex natural material. For this reason, it is necessary to monitor the stone, searching for natural cracks, voids, natural defects and patterns. Frequently, during the cutting-phase, a stone can be damaged which requires another stone to be cut, which will negatively affect the pattern initially specified by the final customer. There's a need to find another stone with similar characteristics, which most of the time is impossible, or readapt the combination of finished stones, so that the pattern can best match the pattern requirements established by the end user. This process is currently performed by human visual inspection.
- REPAIR/REUSE/RECYCLE phase: With respect to repairment, D2TECH adopts a preventive maintenance scheme which is followed by every customer. However, D2TECH does not have in its software the preventive maintenance methodologies at its full capability, e.g. the right tools to assess if a certain component will reach the end of life and prevent failure. Such preventive measures also include the remote installation of updates to the machines software.

After AIDEAS: D2TECH will address the AIDEAS Machine Passport as a driver to support the machine life cycle. Expected contributions of AIDEAS AI Solutions to the different stages of the product life cycle are described below:

- DESIGN phase: By learning from the different patterns of machine usage from their customers, D2TECH would be able to collect such knowledge and use it as an input for the design of new machines. By using an AI-driven approach, common anomalies detected during machine usage could be identified and a root-cause analysis could also be addressed.

An AI-driven approach could assist the designer during conceptualisation of the machine by providing suggestions and notifications highlighting how to improve assembly sequencing orders, the most common anomalies and the components which are affected. Within the design phase it is expected to rely on the AIDEAS CAx Addon and AIDEAS Machine Design Optimiser solutions. [KP11 -35%] [KP24 -10%].

- MANUFACTURING phase: To use an AI-driven approach to improve the calibration process of CNC machines. Regarding the manufacturing phase, it is expected that the AIDEAS Fabrication Optimiser solution will support workers in optimising the machine assembly process, but also to find the best tuning for CNC calibration which is a tedious and error prone process. This solution will be used in the calibration process, by setting the optimal configuration of parameters described in the "before AIDEAS" section. For the sourcing of different suppliers of raw material, this phase will rely on the AIDEAS Procurement Optimiser. [KP19 -25%] [KP26 -20%].
- USE phase: The main motivation of this phase is twofold: (i) Improve short-time production planning; and (ii) Improve machine efficiency (join several orders for similar types of stone). The production of the finished product can be divided into two different sub-phases (configuration and cutting). The objective would be to learn from operators' experience and propose a set of configuration parameters according to each type of stone to be processed. Stone cutting process takes into account a final representation of the final product to be produced, which must reflect the requirements specified initially by the final customer. The motivation is to be able to "scan" each stone individually, creating a digital representation of each stone that is unique. An AI-based approach would be able to react in real-time, by a new combination of tiles, and also the best matching stone to replace a damaged stone. For the initial setup and calibration of the machine, which needs to be adapted for the different types of stones, the AIDEAS Machine Calibrator solution will be considered. For assessing the final product quality, in case of readapting to a new combination of tiles to match the initial pattern defined by the end user, three solutions are being considered: AIDEAS Adaptive Controller, the AIDEAS Anomaly Detector and AIDEAS Quality Assurance. [KP12 -15%] [KPI7 +50%] [KP23 -15%] [KP25 -80%].
- REPAIR/REUSE/RECYCLE phase: Regarding recycle and repair phases, D2TECH aims to establish a servitisation approach which enables the collection of usage data from their machines, in order to optimise and readapt their maintenance programmes to be better tailored to the different needs of the customers. In that sense, using an AI-driven approach it would enable the detection if a particular component reached the end of its life or if it can be repaired. The adoption of the AIDEAS Prescriptive Maintenance, would greatly extend the condition maintenance among its clients. Within this phase the pilot will mainly rely on the following solutions: AIDEAS Smart Retrofitter, which will enable to detect, in case of malfunction or outdated machines, can be retrofitted; AIDEAS LCC/LCA/S-LCA and the AIDEAS Disassembler will enable to easily identify which components have reached the end-of-life and the ones that can be repaired. [KP8 +20%] [KP17 -15%] [KP18 -10%].

3.3.3 Pilot 3: BBM Maschinenbau - AI for Blow Moulding Machines (plastic sector)

Context: BBM Maschinenbau is a German SME mechanical engineering company, specialised in the designing and manufacturing of extrusion blow moulding machines (EBM) for the plastics

industry. EBMs are used for producing all kinds of hollow plastic parts like bottles, canisters, drums, special technical parts, water tanks or even small boats. Since it was founded in 1998, BBM has taken a leading role in technical innovations like replacing hydraulics by electrical components in its machines. Until today, the product portfolio has expanded by the usage of technically advanced and scientifically optimised extruders and extrusion heads. Since the plastics industry is paying more and more attention to ecological and sustainable aspects, BBM is also taking part in finding new and better technologies to support the circular economy by extensive usage of recycled plastics for waste reduction.

Figure 6. BBM Maschinenbau, Blow Moulding Machine.

Before AIDEAS: The current practices in the different stages of the product life cycle are described below.

- DESIGN phase: Until now, BBM's core competence lies in the mechanical engineering of its machines. The machine control and HMI (Human-Machine Interface) is purchased as a license and only the sequence programming is realised by BBM. Programming and debugging are exclusively performed at the machine which leads to extended start up phases. At the moment, BBM is working together with a software development company to create its own industrial logic control and visualisation. In this context, BBM wants to implement state-of-the-art technologies and set an industry control benchmark not only for the plastics industry. During the mechanical engineering and design phase, BBM is working together with IANUS. By using complex simulations, flow channels in the extrusion heads are optimised to increase the possible regrind share and general efficiency and to decrease the times for product colours changes.
- MANUFACTURING phase: BBM subcontracts the manufacturing of mechanical and electrical components resulting in a high amount of purchasing operations, complex monitoring and scheduling of delivery dates. A continuous risk of manufacturing interruptions by delays of suppliers or other environmental influences are a daily concern. To simplify the process of machine assembly, all components need to be at the correct place at the right time which is not the case in every machine project. In addition, the requirements for spontaneous service and maintenance or changes in assembly priorities lead to a complex production resource planning. Due to manual organisation, the available resources are not employed efficiently.
- USE phase: Handling of extrusion blow moulding machines requires a good knowledge of process engineering. Starting from first calibration and referencing of drives, ending with

evaluation of product quality and manually adapting machine parameters, all actions are done manually by the operator.

- REPAIR/REUSE/RECYCLE phase: BBM has started its business with machine overhauls and is still handling many used machines by refurbishing and carrying out automation retrofits. In many cases, when a new extrusion blow moulding machine is delivered by BBM, the replaced machine is taken in deposit and after a workaround and overhaul, sold to another customer as a second hand machine.

After AIDEAS: BBM will use AI technologies developed in AIDEAS to enhance the agility, sustainability and resilience of EBMs through their entire life cycle. In addition, the AIDEAS Machine Passport provides an important database for the optimisation of all life stages of an EBM. Expected contributions of AIDEAS AI Solutions to the different stages of the product life cycle are described below:

- DESIGN phase: BBM aims to improve its current extrusion head design by using the AIDEAS CAx Addon and the AIDEAS Machine Synthetic Data Generator. Instead of just simulating and verifying designs created by mechanical engineers, the AI technologies shall be used to set-up and improve the first design, thereby increasing the expected regrind share of the final product and reducing the workload for the mechanical engineer. By increasing the regrind share, the sustainability of the whole plastics sector can be improved. By using the AIDEAS Machine Design Optimiser, the cycle of machine control creation and debugging will be improved and the expected software start up time will be reduced substantially. The AIDEAS tool will help to create a more realistic machine simulation that helps the electrical engineers to test and debug the machine control before switching it on for the first time. Due to a high amount of dynamic and fast moving machine parts, AI based technologies will help to improve the design and resilience of EBMs. [KPI6 +15%] [KPI11 -20%].
- MANUFACTURING phase: The objective during the manufacturing phase is to ensure the material flow at any time while reducing the stock to a minimum. To achieve this balance, the AIDEAS Procurement Optimiser shall be included in the workflow. With its help, BBM improves the planning and tracking of delivery dates as well as the reaction time to external influences to the original procurement time schedules. Due to the many possible delays and influences to the assembly process (machine breakdowns, delays in deliveries, changes in priorities), a fast and automated reaction is needed to ensure an efficient manufacturing process. The AIDEAS Fabrication Optimiser will be used for the overall production schedule and the human resource planning in the workflow. In addition, the AIDEAS Delivery Optimiser will help to guarantee compliance with delivery times and thus enable an efficient manufacturing process. [KP1 +15%] [KP19 -20%] [KP21 -10%].
- USE phase: During the use phase of an EBM, several AIDEAS AI tools can lead to a significant improvement for BBM as well as for the customer. At first start up, the machine and process parameters need to be set to achieve the best product quality. This complex task will be performed automatically by the AIDEAS Machine Calibrator and it will also help to decrease the initial start-up time and downtime of the machine in the production phase. After a power shut down, the referencing of drives will be handled automatically by the Machine Calibrator based on the previously collected machine data. A running machine in production needs constant condition evaluation and adjustment of parameters, for example due to thermal changes. The AIDEAS Condition Evaluator will create a machine score to easily

evaluate the productivity during the usage. The early detection of abnormal fault conditions of an EBM with the help of the AIDEAS Anomaly Detector will minimise expensive downtimes and time-consuming production halts. And by the subsequent use of the AIDEAS Adaptive Controller, all necessary machine parameters will be adapted automatically. The final product quality will be assessed by the AIDEAS Quality Assurance. Quality deficits can thus be efficiently detected and the manufacturing process can be readjusted accordingly. [KP12 -10%] [KP23 -15%].

- REPAIR/REUSE/RECYCLE phase: In order to increase the lifetime of an EBM, predictive maintenance will play a major role. The AIDEAS Prescriptive Maintenance is the tool that will help to repair or replace components already before a machine breakdown and a production downtime may occur. Besides the reduction of machine downtime for the customer, the new AI tool will help BBM to plan its stock in spare parts. [KP4 +10%] [KP8 +20%].

3.3.4 Pilot 4: Multiscan Technologies - AI for Inspection Machines (food sector)

Context: Multiscan Technologies is a Spanish SME which provides food tooling manufacturing equipment with state-of-the-art machine vision technologies along with innovative product transport systems to achieve optimum sorting. MULTISCAN provides unique computer vision and X-ray solutions for the fresh fruit and vegetables market, mainly quality inspection machines for grading and sorting processes, as well as for safety and conformity applications. MULTISCAN expertise is focused on tooling for small fruits like olives, cherries or cherry tomatoes, being olives its main relevant business and becoming the specialist in stoned fruits of up to 45 mm in diameter. Their products make an extensive use of machine learning models to detect product features like colour, shape, or size from captured camera images and X-Ray detection. Besides these data sources, the machine controller developed by the company collects large amounts of process and product data from auxiliary manufacturing equipment, like feeding engines, and conveyors. Currently, the company is developing a cloud solution to deliver data-driven added value services to their customers based on this data, through a vertical solution that implements open data services, (Manufacturing Execution System) applications and predictive maintenance on top of their manufacturing equipment.

Figure 7. Multiscan Technologies - AI for Inspection Machine.

Before AIDEAS: The current practices in the different stages of the product life cycle are described below:

- DESIGN phase: The company develops the software (including the machine learning models

and algorithms used for grading and sorting, the industrial control logic and the HMI) and the hardware design of their inspection machine. MULTISCAN also designs some of the critical electronic components of their systems, specifically the lightning PCB (printed circuit boards).

- MANUFACTURING phase: MULTISCAN subcontracts the manufacturing of the electronic and mechanical components, including the lightning PCB they design. It is important to highlight that there are rather few providers for some of the critical components of the inspection machines, and due to this, the same providers supply to the other competitors. For these reasons, MULTISCAN is not eager to exchange sensible information with them. These components have a specified lifetime which is then part of the specifications of the product. Sometimes the behaviour of this PCB depends on its manufacturing process and the electronic device, for this reason the quality control of this device must be done when the components arrive at the company. MULTISCAN systems are assembled at their job shop in Alcoy (Alicante). The company has a strong continuous improvement culture and applies lean manufacturing methodologies to improve the production process. Assembled machines are shipped to their network of integration partners, which are in charge of calibrating the products and installing them on customer premises. They also integrate and install entire food processing lines (i.e. they act as an integrator in a secondary line of business).
- USE phase: The calibration of the inspection machine is crucial to adapt to the lightning conditions of the environment and maximise the efficiency of the computer vision algorithms. In the set-up, operators need to configure the sorting process, specifying the features (colour, size, shape) of the product directed to each output. An incorrect configuration may yield high efficiency losses. Besides this, the main downtime causes are due to machine failures due to wearing of components. An embedded line PC implements an OPC UA Server, that provides an interface to other systems, can be used to integrate with the inspection equipment. The controller also collects data from ancillary manufacturing equipment in the line, like feeding engines or conveyors. The OPC UA server publishes these manufacturing data (around 275 variables in total). Currently, MULTISCAN is developing a cloud platform to provide data-driven added value services on top of this data, related to manufacturing operations management (e.g. production KPI monitoring) and predictive maintenance.
- REPAIR/REUSE/RECYCLE phase: When a customer purchases an upgrade, the decommissioned hardware is assembled into units that are sold to other customers, typically in regions like Africa or South America. MULTISCAN collects the equipment and inspects its components to identify those that need to be replaced or upgraded to new versions.

After AIDEAS: MULTISCAN will exploit the potential of the AIDEAS AI technologies as a transformation tool to improve sustainability, agility and resilience of its customers providing AI-based industrial equipment. MULTISCAN aims to use the AIDEAS Machine Passport to conform large datasets consisting of labelled captured images, industrial variables and X-Ray inspection results collected during the use stage. Expected contributions of AIDEAS AI Solutions to the different stages of the product life cycle are described below:

- DESIGN phase: MULTISCAN will use the AIDEAS Machine Design Optimiser to optimise the

lighting conditions of the computer vision system based on physical models. The modules will be integrated in CAD tools (through the AIDEAS CAx Addon) to ensure a seamless adoption of the optimisation modules by the engineering team. The AIDEAS Machine Synthetic Generator will be used to simulate operating conditions not found in the AIDEAS Machine Passport datasets, for instance when the product design needs to be adapted for new types of fruits. [KPI5 +10%] [KPI6 +10%].

- MANUFACTURING phase: The main objective is to use the AIDEAS Fabrication Optimiser to optimise the assembly and quality control processes, supporting the agile manufacturing methodologies used currently in the factory with fast planning and sequencing tools. This will help the company make an efficient use of their human and technical resources while at the same time shortening the delivery dates of the production orders. Additionally, the AIDEAS Procurement Optimiser will be used to minimise component stocks and ensure material flows. [KPI19 -10%] [KPI21 -15%].
- USE phase: Based on the datasets obtained through the AIDEAS Machine Passport, the objective is to automate the initial calibration of the lightning PCBs, learning the relationship between the information collected on customer premises describing the installation and its environment and the optimal configuration parameters of the PCB lightning board. The approach is to use the AIDEAS Machine Calibrator solution to calibrate the machine parameters, yielding shorter installation times and requiring no advanced skills nor training for the installation. Another objective is to use the AIDEAS Adaptive Controller to detect and correct errors in the set-up of the machine and the AIDEAS Quality Assurance time series forecasting features to predict the quality breakdown (quantity of each product category produced), from the information coming from the sensors placed in the machine, the surrounding environment, and other connected systems. Moreover, the labelled images in the datasets will be used to improve the performance of the machine learning models that perform the sorting and grading processes. The availability of large datasets will significantly improve the system resilience and the ability of the models to learn the properties of products under different conditions, allowing to work more efficiently with new varieties or under new seasonal characteristics. [KPI14 -20%] [KPI25 -75%].
- REPAIR/REUSE/RECYCLE phase: The AIDEAS Smart Retrofitter will be used to improve the retrofitting of components, allowing to effectively detect components that need to be replaced and facilitating the inspection process in decommissioned equipment. The AIDEAS Prescriptive Maintenance can use the AIDEAS Machine Passport datasets to estimate the remaining useful life (RUL) of mechanical components and maintenance plans adapted to the individual characteristics of the machine. [KPI4 +10%] [KPI17 -15%].

4 Positioning

The general objective of the AIDEAS exploitation activities is to facilitate technology uptake by early adopters and long-term adoption of AIDEAS technology in the industry. The positioning will be done by the FBA team in order to assure the smooth exploitation strategy.

4.1 Context

The main objectives of the exploitation activities are showing the general scope of the actions that will re-force the commercial roll-out of the AIDEAS final products:

- O1 Disseminate and assess the project results with stakeholders via continuous communication.
- O2 Create the Community of stakeholders and early adopters for impact creation.
- O3 Increase the market uptake through Customer Discovery Loop and Market Validation experiments.
- O4 Implement an effective IP monitoring plan.
- O5 Adapt the project results to existing standards and regulatory frameworks

4.1.1 Business opportunities

The exploitation process in the AIDEAS project starts with the preliminary Business Model. This plan will be validated (or confronted and reviewed) during the project's implementation by following a lean approach. The business model describes how the KERs are positioned within its value chain, and how it organises its relations with its suppliers, clients, and partners to generate profits. The business plan translates this positioning into a series of strategic actions and quantifies their financial impact. This section defines an outline of the Business Models (based on Lean Canvas approach) as shown in Figure 8.

- Lean Canvas: At this stage, a first Lean Canvas for each KER has been assembled thanks to feedback gathered during the proposal phase from both partners of the consortium and potential customers.
- Hypothesis on the most adequate Exploitation Strategy: The foreseen joint exploitation Strategy by the consortium is the uptake by commercial partners like IANUS, IKERLAN, CESI, UPV (via EXOS), CERTH (via INFALIA) that will uptake the AIDEAS solutions and will bring it to the market. The presented strategy is based on answers from a survey that was gathered from all participating project partners, specifically focusing on the owners of the KERs.
- Main integrated KER: Following the exercise described previously, the Customer Discovery Loop, the Lean Canvas will evolve into one single Business Model encompassing all KERs. The joint exploitation strategy focuses on exploring ways to exploit the integrated KERs that are resulting from the project and can be summarised as follows:

AIDEAS Suites are software toolkits based on AI technologies for supporting the entire life cycle (design, manufacturing, use and repair/reuse/recycle) of industrial equipment as a strategic instrument to improve sustainability, agility and resilience of the European machinery manufacturing companies.

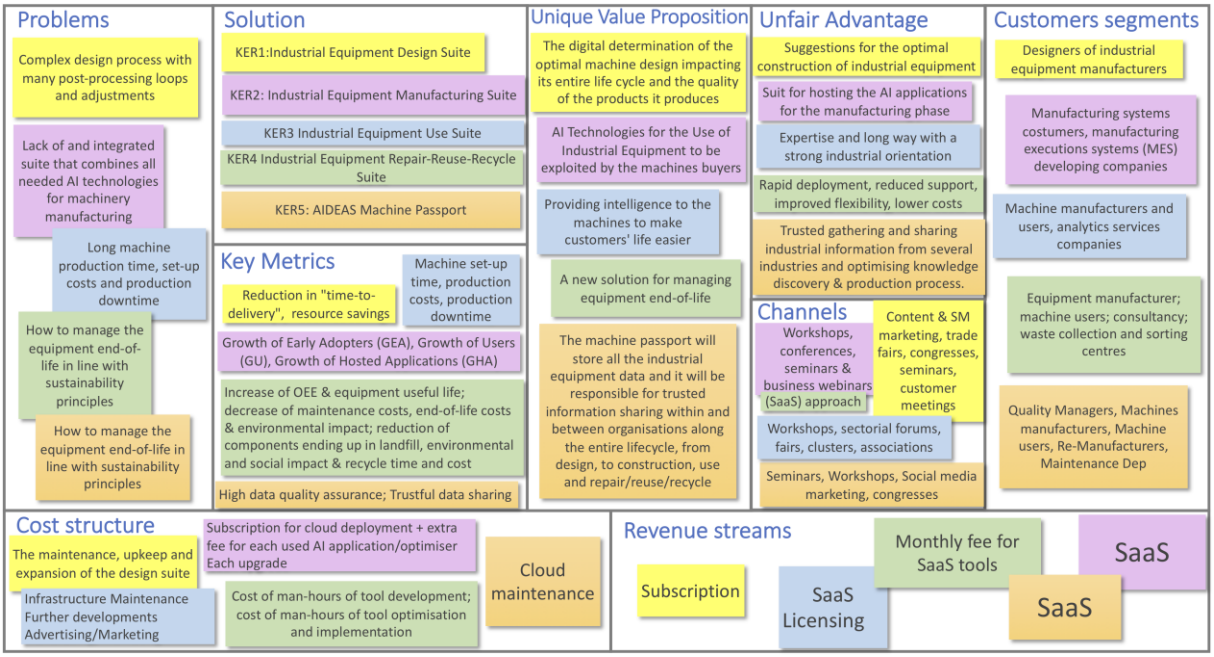

Figure 8. AIDEAS Lean Canvas.

4.1.2 Stakeholders

There are different groups of stakeholders who will benefit from AIDEAS project results. They belong to the industrial sectors of AIDEAS Pilots as well as to other industrial sectors or other interested stakeholder groups such as technology providers, integrators, standardisation bodies, etc.

☒ The **European Industrial Equipment Manufacturers** are the primary target group, they will benefit from the results of the **AIDEAS** project by having a comprehensive system, based on AI technologies, for the improvement of processes throughout the entire life cycle of industrial equipment (design, manufacture, use and repair/reuse/recycling). Machine designers will be able to use the **AIDEAS Industrial Equipment Design Suite** to optimise their designs. Production and logistics managers can use the **AIDEAS Industrial Equipment Manufacturing Suite** to optimise their processes. With the **AIDEAS Industrial Equipment Use Suite**, Industrial Equipment Manufacturers will be able to provide their customers with advanced tools based on AI technologies associated with their machines, which will increase their competitiveness against competitors that do not provide such technologies (e.g. Chinese Industrial Equipment Manufacturers). With the **AIDEAS Industrial Equipment Repair-Reuse-Recycle Suite**, they will be able to recover their machines at the end of their first life and prepare them for a second use in other markets, or recycle machine components and materials. Finally, with the **AIDEAS Machine Passport** they will provide a high added value to their products, based on the storage of machine data in all phases of their life cycle.

☒ The **European Manufacturing Industry** is the secondary target group, they will benefit from the **AIDEAS Industrial Equipment Use Suite**, which Industrial Equipment Manufacturers will provide together with the machines sold. This Suite provides advanced tools based on AI technologies for rapid machine calibration, both at first installation and configuration changes during use; for rapid assessment of machine operating condition; for advanced detection of machine malfunctions; for

adaptive control to changing manufacturing conditions; and for achieving product quality assurance through AI-based monitoring. All industrial sectors, which use industrial machinery for the manufacture of their products, will be able to benefit from these solutions.

☒ The **Manufacturing Infrastructure Providers** will benefit from the results of the **AIDEAS** project by optimising the components (mechanical, hydraulic, electronic, electric motors, tools) that they supply to Industrial Equipment Manufacturers, through the use of the **AIDEAS** Industrial Equipment Design Suite (design optimisation) and the **AIDEAS** Industrial Equipment Manufacturing Suite (manufacturing optimisation). Such optimisation will result in an increase in competitiveness against their competitors, contributing to the reduction of component design times, the improvement of their quality and the reduction of production costs.

☒ The **Digital Technologies Providers** will benefit from the results of the **AIDEAS** project by providing hardware or software that connects to the **AIDEAS** Solutions thanks to their interoperability. Sensors Manufacturers, Actuators Manufacturers and Hardware Developers will see an increased demand for their products from Industrial Equipment Manufacturers who will integrate these components into their machine designs. Software Developers will be able to develop add-ons to **AIDEAS** Solutions due to the open source software developed in the **AIDEAS** project. AI Engineers and Data Scientists will be able to contribute their AI and Data Analytics algorithms to the catalogue of techniques of the **AIDEAS** Solutions.

☒ The **Service Providers** are a heterogeneous target group that will be able to benefit from several of the solutions provided by the **AIDEAS** project depending on the service they provide to their customers. Industrial Equipment Installers, Machinery Configurators and Systems Integrators will be able to use the **AIDEAS Machine Calibrator** for quick installation and configuration of machinery. Maintenance Companies will be able to use the **AIDEAS Prescriptive Maintenance** to provide a value-added maintenance service. Recycling Companies can use the **AIDEAS LCC/LCA/S-LCA** for cost, environmental and social assessment and the **AIDEAS Disassembler** to optimise machine disassembly operations for recycling. The Training Companies will be able to provide training services to companies using the solutions developed by the **AIDEAS** project.

☒ The Human Workforce of the Industrial Equipment Manufacturers will benefit from the advantages provided by the **AIDEAS Industrial Equipment Manufacturing Suite**, which will optimise their work in the machinery manufacturing process. The Human Workforce of the Manufacturing Industry will benefit from the advantages provided by the **AIDEAS Industrial Equipment Use Suite** that will facilitate their work by human-centric AI technologies. Consumers of products manufactured by the Manufacturing Industry using the **AIDEAS Industrial Equipment Use Suite** will benefit from improved quality and more competitive costs of manufactured products. The Trainees and Students will benefit from training in the **AIDEAS** advanced technologies, which will add value to their CVs.

The AIDEAS **Community** goal is to create a rich and dynamic ecosystem of active members, representing all relevant stakeholders, encouraging them to interact, chat, exchange knowledge, find synergies and get value from a community of peers in the AI in Machines Design, Manufacturing, Use and Reuse. In order to achieve that, firstly, strategic issues, such as defining a clear-cut purpose for the community and building a strategy to attract and retain users, must be considered while the Community's online platform is customised on FundingBox Platform.

Afterwards, the activities defined in the Growth Hacking Strategy will be implemented for attracting stakeholders interested in cooperating with the project in a 'win-win cooperation mode'.

4.1.3 Post-project Commercialisation

Individual exploitation efforts, distinctive components/subsystems of the KERs with potential to be commercialised as stand-alone components for other applications, have also been considered. The exploitation strategy, business opportunities and type of protection have been already identified for the OERs, which are the AIDEAS Solutions:

- Exploitation Strategy: Software toolkit marketed with 2 options: A) Standalone software, B) SaaS (software as a service).
- Business Opportunities: New product for i) Industrial Equipment Manufacturers, ii) Manufacturing Infrastructure Providers, iii) Digital Technologies Providers, and iv) Service Providers: Systems Integrators, Industrial Equipment Installers, Machinery Configurators, Maintenance Companies, Recycling Companies and Training Companies.
- Type of Protection: Mainly open source with punctual trade secrets.

4.2 Contribution of AIDEAS results

The results of the AIDEAS project will contribute to the following areas:

TECHNOLOGICAL: AIDEAS will pave the way for a broad adoption of AIDEAS Solutions in the industry, offering benefits for final users, and to create the AIDEAS standards, compliant with existent and evolving ICT and CE standards, promoting regulation, certification and to facilitate technology uptake and long-term adoption of the AIDEAS Solutions by the machinery manufacturing industry. Activities to achieve objective O9 of AIDEAS project will include the verification and implementation of actions aiming at the achievement of trustworthy AI technologies to follow a fair, consistent process and make fair decisions. It also includes internal and external checks to reduce discriminatory bias and increase AI explainability. A classification of the different types of data and/or information will be provided and analysed with the aim of assessing which regulation such as personal data, intellectual or industrial property, trade secrecy or data protection, among others, should apply. Furthermore, collateral aspects such as the ownership of generated data or cyber security measures will be evaluated as well as other potential topics which may impact the data protection. After identifying a set of propositions and barriers in relation to the referred issues, recommendations will be provided.

ENVIRONMENTAL: AIDEAS will develop AI generative solutions which, starting from data collected throughout the product life cycle (Machine Passport), will create continuous improvement cycles. In particular, in WP3 and WP4, AI-assisted optimisation modules will be developed that can generate concrete product design suggestions for the optimal construction of industrial equipment, allowing companies to reduce waste. These optimisation modules will be embedded into the overall design workflow. The calibration and anomaly detection AIDEAS Solutions developed in WP5 will allow companies to reduce energy consumption during the utilisation phase. Moreover, AIDEAS LCC/LCA/S-LCA and AIDEAS Disassembler tools (WP6) enable

more useful disassembly and recycling information to be fed back to engineers at the planning and design phase. The development of AI solutions based on LCC, LCA and S-LCA analysis ensures compliance with the three pillars of sustainability (Triple Bottom Line).

ECONOMIC: AIDEAS Procurement Optimiser, AIDEAS Fabrication Optimiser and AIDEAS Delivery Optimiser tools (WP4) allow industrial equipment companies to increase agility by operating in a predictable manner even in the face of extreme complexity. Product or processes delivery schedules can be predicted much more accurately in order to get much faster to market. AIDEAS Machine Design Optimiser and AIDEAS CAx Addon tools (WP3) will increase the ability to respond to the changing needs of customers (resilience). In WP5, AIDEAS Machine Calibrator, AIDEAS Anomaly Detector and AIDEAS Quality Assurance tools will provide the company with delivering products to market with the speed and accuracy that customers demand. Moreover, AIDEAS Condition Evaluator and AIDEAS Adaptive Controller tools (WP5) guarantee the agility requires both ad-hoc reactions on what is happening in a specific situation and also adaptation of the organisation in the long run. Finally, the standardisation tasks and AIDEAS Machine Passport will facilitate companies to not be tied to a specific supplier, but to support a full range of suppliers.

SCIENTIFIC: AIDEAS will develop AI technologies for supporting the entire life cycle of industrial equipment: design, manufacturing, use and end-of-life. AI technologies for the industrial equipment end-of-life (repair-reuse-recycle) will be developed in the objective O6. Moreover, AIDEAS will support a circular production by developing AI solutions for repairing, reusing and recycling industrial equipment. In particular, in the WP6 four tools will be created: AIDEAS Prescriptive Maintenance (repairing), AIDEAS Smart Retrofitter (reusing), AIDEAS LCC/LCA/S-LCA and AIDEAS Disassembler (recycling). Moreover, the proposed machine passport will facilitate manufacturers looking for reliable and convenient data on product designs, pathways, and composition in order to determine their potential for a Circular Economy (CE), including: optimal productivity, recycling vs. downcycling, and optimising residual value of materials.

5 Project Results

5.1 AIDEAS Solutions

With regard to the Technology Readiness Levels (TRL), it is expected that the AIDEAS consortium will fine-tune and enhance their own or existing products with solid background (at least TRL 4), and some commercial grade-product, and thereby show at least TRL 7 for all AIDEAS Solutions (Table 2).

Project Results: AIDEAS Solutions integrated in the AIDEAS Suites	Code	OBJ	Leaders	Supporting Technologies	Start TRL	Final TRL
AIDEAS Industrial Equipment Design Suite	AI^{IEDS}	O3	IANUS	Docker, Kubernetes, Scikit-learn, Tensorflow, Keras		
AIDEAS Machine Design Optimiser	AI^{MDO}	O3	IKERLAN	OpenModelica, ZDMP Digital Twin	4	7
AIDEAS Machine Synthetic Data Generator	AI^{MDG}	O3	IANUS	StrömungsRaum®, ZDMP Prediction and Optimisation Designer, ZDMP Prediction and Optimisation Runtime, ZDMP AI Analytics Runtime	4-5	7
AIDEAS CAx Addon	AI^{CAx}	O3	XLAB	WSO2, Django, Angular, CuraEngine	4	7
AIDEAS Industrial Equipment Manufacturing Suite	AI^{IEMS}	O4	TAU	Docker, Kubernetes, Scikit-learn, Tensorflow, Keras		
AIDEAS Procurement Optimiser	AI^{PO}	O4	ITI	ZDMP Prediction and Optimisation Designer, ZDMP Prediction and Optimisation Runtime, ZDMP AI Analytics Runtime, ForePlanner's AI libraries and technology base	4-5	7
AIDEAS Fabrication Optimiser	AI^{FO}	O4	UNIVPM	IFS (planning-scheduling-optimization), celayix (scheduling-tool), optaplanner, mosaicdatascience, bakerhughesc3, ZDMP Prediction and Optimisation Designer, ZDMP Prediction and Optimisation Runtime, ZDMP AI Analytics Runtime	4-5	7
AIDEAS Delivery Optimiser	AI^{DO}	O4	TAU	PuLP, FASToryDigitalTwin, ZDMP Prediction and Optimisation Designer, ZDMP Prediction and Optimisation Runtime, ZDMP AI Analytics Runtime	4-5	7
AIDEAS Industrial Equipment Use Suite	AI^{IEUS}	O5	IKERLAN	Docker, Kubernetes, Scikit-learn, Tensorflow, Keras		

AIDEAS Machine Calibrator	AI^{MC}	O5	UNINOVA	ZDMP Prediction and Optimisation Designer, ZDMP Prediction and Optimisation Runtime, ZDMP AI Analytics Runtime	4	7
AIDEAS Condition Evaluator	AI^{CE}	O5	IKERLAN	DEWESoft, Siemens Mindsphere Apps, ZDMP Prediction and Optimisation Designer, ZDMP Prediction and Optimisation Runtime, ZDMP AI Analytics Runtime	4-5	7
AIDEAS Anomaly Detector	AI^{AD}	O5	IKERLAN	TIBCO, SKF Enlight AI, ZDMP Prediction and Optimisation Designer, ZDMP Prediction and Optimisation Runtime, ZDMP AI Analytics Runtime	4-5	7
AIDEAS Adaptive Controller	AI^{AC}	O5	IKERLAN	PILCO, ZDMP Process Assurance Run-time	4	7
AIDEAS Quality Assurance	AI^{QA}	O5	XLAB	PyTorch, Nvidia DeepStream, OpenCV, ZDMP Product Assurance Run-time – Quality Prediction Designer, ZDMP Product Assurance Run-time – Product Quality Supervision	4-5	7
AIDEAS Industrial Equipment Repair-Reuse-Recycle Suite	AI^{IERS}	O6	UNIVPM	Docker, Kubernetes, Scikit-learn, Tensorflow, Keras		
AIDEAS Prescriptive Maintenance	AI^{PM}	O6	IKERLAN	AVEVA, ZDMP Prediction and Optimisation Designer, ZDMP Prediction and Optimisation Runtime, ZDMP AI Analytics Runtime	4-5	7
AIDEAS Smart Retrofitter	AI^{SR}	O6	UNIVPM	smartfactory-owl, splunk, pega,	4	7
AIDEAS LCC/LCA/S-LCA	AI^{LC}	O6	UNIVPM	circul8, simapro; sphera, openlca; nist; psilca	4-5	7
AIDEAS Disassembler	AI^{DIS}	O6	UNIVPM	corba, pro-engineer, gabi.sphera, ipoint-systems	4	7
AIDEAS Machine Passport	AI^{MP}	O3,O4, O5,O6	CERTH	ZDMP Application Run-time, ZDMP Data Acquisition, ZDMP Data Harmonisation Designer and Runtime, ZDMP Storage, ZDMP Secure Authentication and Authorisation	4	7

Table 2. Maturity of AIDEAS results.

5.2 AIDEAS Standards

Standardisation is an important and helpful tool to make project results known outside the project and to strengthen the dissemination and application of the developed AIDEAS solutions in the industry. Furthermore, standardisation is a widely accepted tool for lowering trade barriers due to an agreement on field-specific terminologies, methodologies, construction methods and a wide

range of other criteria. For these reasons, it is essential that applicable standards are taken into account in the development of AIDEAS Solutions and that identified gaps are ideally closed, based on the project results. This is exactly what **Task 8.7 Standardisation** will address. The goals of this task are to connect to standardisation forums and to monitor the project to ensure compliance of the project results with existing standards.

In the first step, standards research is carried out to identify all existing standards and ongoing developments of standards at national, European and international level and the associated committees which are relevant for AIDEAS Project. The identified standards and committees are then evaluated by the members of the consortium. The evaluated results will be distributed within the consortium to be taken into account in the implementation of the project activities.

In addition, the project will also actively contribute to standardisation by e.g. participating at ISO and CEN working groups, as far as appropriate, and possibly prepare to undertake input to the standardisation process. Therefore, project specific standardisation needs will be collected and assessed through a workshop and discussions with project partners until M24. If suitable project results are identified, DIN will apply for the conduction of a CEN Workshop to create a CEN Workshop Agreement (CWA). AIDEAS will engage with the European standardisation process, specifically CEN, CENELEC and DIN, along with other relevant stakeholders. Thus, the AIDEAS project will be in an ideal position to provide the right level of standard interfaces. All R&D and TECH partners will actively support this task and USER partners will provide the standardisation needs on the industrial equipment manufacturing sector.

6 Deliverables and Milestones

All work packages have clear milestones, and all tasks have deliverables, which are the official outputs of the project.

The AIDEAS project's deliverables (D) are listed in the table below (Table 3).

Del. no.	Deliverable name	WP no.	Lead partici-pant	Type	Dissemi-nation level	Delivery date (month)
D1.1	Project Vision Guide Document	1	CERTH	R	PU	4
D1.2	Benchmarking of AI Technologies with potential to AIDEAS	1	ITI	R	PU	5
D1.3	Demonstration Scenarios and Monitoring KPIs Definition	1	CESI	R	SEN	4,11
D1.4	Requirements Analysis and Functional Specification	1	ITI	R	PU	6,12
D2.1	AIDEAS Reference Architecture	2	UPV	R	PU	3,9
D2.2	AIDEAS Viewpoints	2	CERTH	R	PU	9,18
D3.1	AIDEAS Industrial Equipment Design Suite	3	IANUS	OTHER	PU	18,24,30,36
D4.1	AIDEAS Industrial Equipment Manufacturing Suite	4	TAU	OTHER	PU	18,24,30,36
D5.1	AIDEAS Industrial Equipment Use Suite	5	IKERLAN	OTHER	PU	18,24,30,36
D6.1	AIDEAS Industrial Equipment Repair-Reuse-Recycle Suite	6	UNIVPM	OTHER	PU	18,24,30,36
D7.1	Piloting and Demonstrating	7	UNINOVA	DEM	SEN	24,36
D7.2	Impact assessment and KPI validation of AIDEAS solutions	7	UNINOVA	R	SEN	30,36
D7.3	Roadmap, replicability and lessons learned	7	UNINOVA	R	PU	30,36
D8.1	Dissemination, Communication and Community Building	8	UPV	DEC	PU	12,24,36
D8.2	Exploitation and Intellectual Property Management	8	FBA	R	SEN	12,24,36
D8.3	Key Exploitable Results, Business Model Canvas and End Users/Customers' Validation	8	FBA	R	PU	6,36
D8.4	Standardisation	8	DIN	R	PU	12,24,36
D9.1	Project Handbook	9	CERTH	R	SEN	3
D9.2	Periodic Administrative and Technical Reports	9	CERTH	R	SEN	12,24,36
D9.3	Data Management Plan	9	ITI	DMP	SEN	6,24,36
D9.4	Regulation and Trustworthy System	9	ITI	R	SEN	18,36

Table 3. List of deliverables.

A number of high-level milestones have been adopted ensuring that each major cycle of the project is completed on time. The list of milestones (MS) of AIDEAS project is presented in Table 4.

M#	Milestone name	Related WP(s)	Due date (month)	Means of verification
M1	Project planning and management structure set-up	9	1	Project Planning defined / Project Management Structure set-up / Project monitoring, control, quality and communication Handbook available
M2	Project Vision Consensus established	1	3	Project Vision Guide Document signed by all partners
M3	Project Dissemination Strategy implemented	8	3	Project Dissemination Strategy defined / AIDEAS website set-up and running / Initial release of the public part of the dissemination materials available
M4	Requirements identified and assessed	1	6	List of Requirements with average assessment from all partners valorisation published in the AIDEAS Project website
M5	Architectural and methodological foundations for the framework delivered	2	9	Detailed Specification of the AIDEAS technical architecture. / Framework of the Project Released.
M6	Freedom to operate of the KERs confirmed	8	12	Analysis report that confirms the FTO
M7	Exploitation strategy plan developed	8	12	Exploitation strategy available for all partners at the project intranet
M8	Periodic progress reports and cost statements released	9	12, 24, 36	Periodic Progress Reports including Financial Statements submitted and approved by EC
M9	Standardisation needs identified	8	12	Minutes of standardisation workshop and list of proposed standardisation needs.
M10	AIDEAS Solutions 1st Release	3, 4, 5, 6	18	Software R1 ready for installation and use by Pilots.
M11	AIDEAS Solutions 2nd Release	3, 4, 5, 6	24	Software R2 ready for installation and use by Pilots.
M12	AIDEAS Solutions addressed to each Pilots tested in factory equipment	7	24	Video report of the AIDEAS Solutions being tested in factory equipment
M13	AIDEAS Solutions Intermediate Releases	3, 4, 5, 6	30, 36	Software intermediate releases ready for installation and use by Pilots.
M14	AIDEAS Solutions addressed to each Pilots validated in test production	7	30	Video report of the AIDEAS Solutions being used in test production
M15	AIDEAS Solutions addressed to each Pilots running in production	7	36	Video report of the AIDEAS Solutions running in real production

Table 4. List of Milestones.

7 Risks

The critical implementation risks and mitigation actions of AIDEAS project are presented below (Table 5):

Description of risk (likelihood/ severity)	WPs involved	Proposed risk - mitigation measures
Failure to meet milestones (Medium/Low)	ALL	Problems and risks are promptly identified and rapid adaptation to changes affecting the project planning is conducted through effective project management. The Technical Manager (UPV) is responsible for the early problem identification and arrangement.
Lack of coordination or poor communication (Low/Medium)	ALL	The highly experienced Project Coordinator (CERTH) has sufficient knowledge in project management. Additionally, all involved partners have participated in projects of equivalent level and standards. The strategic planning regarding project management schemes and actions will ensure adequate operational qualification and it will enable the in time project execution without obstacles.
Under/over estimation effort (High/Medium)	ALL	To address this risk special indicators will track the ratio of actual required effort versus the planned one, on a regular basis. The Project Coordinator (CERTH) and the Technical Manager (UPV) will obtain feedback from Task Leaders frequently, in order to ensure feasibility.
Deliverable failure due to missed deadline or poor deliverable quality (Medium/Low)	ALL	The AIDEAS project will adopt quality management and assurance policies. Each deliverable will be extensively reviewed by two project partners. Each task will be overviewed by the respective task leader. The final check regarding deliverable consistency and adequacy is applied by the Technical Manager (UPV). Whenever insufficiencies arise, complementary actions can be requested from partners by the work package leaders, the Technical Manager, and the Project Coordinator. This procedure will ensure each deliverable's compliance with the project's contractual requirements.
Lack of required know-how (Low/High)	ALL	All involved participants have been carefully selected in order to satisfy the project requirements. Their skills and experience have been thoroughly examined. Their successful participation in several EC funded projects evidences their capacity.
Loss of Beneficiary (Medium/Low)	ALL	If the terminated activity is included in the AIDEAS consortium, the respective funding along with the respective work will be assigned to the remaining active partners. If the aforementioned action cannot be implemented, another organisation with similar specifications, standards, and characteristics will be exploited.
Loss of required know-how due to departure of key personnel (Medium/Low)	ALL	If the key personnel depart from the AIDEAS project the consortium is obligated to replace them as quickly as possible. The alternative personnel will be easily integrated in the project by following a quick familiarisation scheme that will be set. The goal of this scheme is to reduce the required training time to minimum while keeping the standards high.
COVID-19 impact on project (High/Low)	ALL	The project will plan all meetings by respecting regulations and travel restrictions according to the current status of the pandemic in Europe. Telco conferencing will always be available to ensure communication in the consortium. No risks will be taken with regard to meetings and traveling which could lead to potential COVID-19 related health complications.
Unclear requirements (Low/Medium)	WP1	The definition of the industrial scenarios and the requirement analysis for industrial equipment design, manufacturing, use and repair-reuse-recycle might lead to forming ambiguous requirements. This risk is eliminated by the

		definition of a clear set of specifications driving the creation of the lighthouse demonstration case of the AIDEAS Solutions (T1.4).
Lack of generality of identified requirements (Low/Medium)	WP1	To confront this risk, the pilots' selection is carefully conducted. Their respective companies correspond to several European industry sectors and cover a wide range of requirements and characteristics.
Weak software design (Low/High)	WP2	There is a complete work package (WP2) dedicated to the design of the AIDEAS Reference Architecture and the viewpoints (Business, Usage, Functional, Implementation) following the ISO/IEC/IEEE 42010 standard and the most common reference architectures in the manufacturing domain, such as IIRA (mainly), RAMI4.0, IDSA, and IMSA.
Complex AI technologies for Design (Medium/High)	WP3	WP3 will develop AI technologies for optimising the design phase of industrial equipment which have to be integrated with existing design software, i.e. CAD/CAM/CAE. The risk of failure in such development or integration is mitigated due to the participation of specialist in machinery design (IANUS, XLAB) and the high expertise of all R&D and TECH partners in AI.
Complex AI technolog. for Manufacturing (Medium /High)	WP4	WP4 will develop AI technologies for optimising the manufacturing phase of industrial equipment for optimising procurement, fabrication and delivery stages. The risk of failure in such development or integration is mitigated due to the participation of specialist in machinery manufacturing (TAU, ITI) and the high expertise of all R&D and TECH partners in AI.
Complex AI technologies for Use (Medium /High)	WP5	WP5 will develop AI technologies for optimising the use phase of industrial equipment for its calibration, evaluation, detection, control and quality assurance. The risk of failure in such development or integration is mitigated due to the participation of specialist in machinery use (IKERLAN, CERTH) and the high expertise of all R&D and TECH partners in AI.
Complex AI technologies for R/R/R (Medium /High)	WP6	WP6 will develop AI technologies for optimising the Repair/Reuse/Recycle phases of industrial equipment for maintenance, retrofitting, disassembling and LCC/LCA/S-LCA. The risk of failure in such development or integration is mitigated due to the participation of specialist in machinery recycling (UNIVPM, UNINOVA) and the high expertise of all R&D and TECH partners in AI.
Unavailability of datasets (High/Low)	WP7	There is a risk for the Pilots not providing datasets or these not being relevant for the necessary applications and solutions' development. However, there will always be the possibility of generating synthetic datasets, as relevant as possible to the considered use cases and solutions.
Other similar solutions already present on the market (Medium/Low)	WP1, WP8	The AIDEAS Solutions will be characterised by the state of art in terms of technologies for industrial equipment design, manufacturing, use and repair-reuse-recycle. These solutions will be practical, effective, affordable and user friendly. The market will be closely tracked by the consortium members, in order to identify possible emerging competitors immediately. AIDEAS Solutions will be optimised in order to offer noticeably unique solutions in industry.
Difficulties in exploitation (Low/Medium)	WP8	To alleviate this risk, the AIDEAS project's results will be tested through the validation of its i) Desirability (Solving Customer-related uncertainty), ii) Feasibility (Testing available technology and resources, activities and partners) and iii) Viability (Financial opportunity assessment) (T8.5). A validated Business Model will be developed to allow partners to position themselves with a clear go-to-market status.
Poor/ineffective dissemination (Low/Medium)	WP8	A project dissemination strategy will be developed within T8.1 aiming to link the project with the industrial sector and other stakeholders who may be interested in the project outcomes in order to achieve the maximum interaction with the different target groups.

Legal issues arising from data management (Low)	WP9	The AIDEAS project will classify and analyse different types of data that will be involved in the AIDEAS Solutions. These data are related to personal information, industrial properties, processes, and trade and they are mainly derived through the equipment design, manufacturing, use and repair/reuse/recycle phases. They will be protected by applying the necessary regulations, aiming at increasing trust.

Table 5. Critical risks for implementation

8 Conclusions

Deliverable D1.1 serves as a project vision guide document and provides an overview of the main aspects of AIDEAS Project. It will act as a reference for the project and will be used by all partners to stay focused on the main ideas and goals of AIDEAS. The document will also be used internally to keep the performed tasks in synchronisation with the overall idea of the project. It can also be used by the partners as a source for documents, deliverables and presentations to third parties to get an early overview of the project. In addition, this document includes an initial risk table, adopted by the DoA, which itemises general inherent risks of innovation activities. The main goal of this deliverable is to map the solutions offered by technology providers to the requirements of the pilots. The vision of the project was clearly explained and the AIDEAS Solutions were listed and described.

To sum up, AIDEAS will develop AI technologies for supporting the entire lifecycle (design, manufacturing, use, and repair/reuse/recycle) of industrial equipment as a strategic instrument to improve sustainability, agility and resilience of the European machinery manufacturing companies. It will create 4 AIDEAS Suites, namely; AIDEAS Industrial Equipment Design Suite, AIDEAS Industrial Equipment Manufacturing Suite, AIDEAS Industrial Equipment Use Suite, AIDEAS Industrial Equipment Repair-Reuse-Recycle Suite, and 1 AIDEAS Machine Passport as Key Exploitable Results.

The 4 AIDEAS Suites are composed by 15 AIDEAS Solutions, which aim to improve a set of Key Performance Indicators (KPIs), linked with the AIDEAS specific objectives: AIDEAS Machine Design Optimiser (AI^{MDO}), AIDEAS Machine Synthetic Data Generator (AI^{MDG}), AIDEAS CAx Addon (AI^{CAx}), AIDEAS Procurement Optimiser (AI^{PO}), AIDEAS Fabrication Optimiser (AI^{FO}), AIDEAS Delivery Optimiser (AI^{DO}), AIDEAS Machine Calibrator (AI^{MC}), AIDEAS Condition Evaluator (AI^{CE}), AIDEAS Anomaly Detector (AI^{AD}), AIDEAS Adaptive Controller (AI^{AC}), AIDEAS Quality Assurance (AI^{QA}), AIDEAS Prescriptive Maintenance (AI^{PM}), AIDEAS Smart Retrofitter (AI^{SR}), AIDEAS LCC/LCA/S-LCA (AI^{LC}), AIDEAS Disassembler (AI^{DIS}).

The AIDEAS Solutions will be demonstrated in 4 Pilots of machinery manufacturers that provide industrial equipment to different industrial sectors: metal, stone, plastic and food.