DIGITAL MANUFACTURING PLATFORMS FOR CONNECTED SMART FACTORIES

D1.10 3rd Report on Open Calls

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Abstract : This deliverable reports on the activities performed from April to June 2021 to carry out and disseminate the open call. The deliverable also gathers all the documents issued by the QU4LITY consortium for the applicants of the second open call.

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Table of Contents

HISTORY

Version	Date	Modification reason	Modified by
0.1	03/06/2021	TOC	Carmen Polcaro (INNO)
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List of Figures

1 Executive Summary

This deliverable reports on the activities performed to carry out the QU4LITY 2nd Call for Proposals, opened on April 15th: complete the support documentation, perform dissemination actions, give support to potential applicants, build the team of experts and finally start the evaluation process. The deliverable also gathers all the documents issued by the QU4LITY Consortium for the applicants.

Next steps are completing the evaluation of the second call, publish the results, starting the contracts with the winners.

2 Introduction

2.1 Scope of the document

Deliverable 1.10 reports on the work performed by the consortium of the project during the QU4LITY 2nd Open Call. The call was open for the reception of proposal from April 15th to June 18th. During the reported period of the corresponding task the consortium has been engaged in the following activities:

- Definition of the QU4LITY assets to be validated within the open call
- Preparation of the documents to give support to the applicants
- Performing dissemination actions
- Giving support to applicants
- Definition of the criteria to build the team of evaluators
- Starting the evaluation process
- Analysing the results and extract lessons for the next open call

The preparation/definition of the open call started in February 2021 and the present report covers the work done until June 2021.

3 Report on the 2nd QU4LITY open call

3.1 Introduction

The previous deliverable D1.9 "Second report on the open call" is a report on the first open call of the project, which was open from June 8th to September 18th, 2020. In this report there is information about dissemination actions, requirements for applicants, as well as an analysis of the proposals received.

In this third report, deliverable D1.9, we include the same information and analysis but in this case for the 2nd open call of QU4LITY.

3.2 Results of 1st Open call

As explained in the "Guide for applicants" document available to interested SMEs, the submission of proposals and their evaluation is done through the EMS (Evaluation Management System) tool. This tool has the ability to send to the applicants the result of the evaluation, giving a report on their score as well as the strengths and weaknesses of the submitted proposals.

In the case of the 1st open call, the results of the evaluation were obtained in October 2020, the month in which the 14 applicants were informed of the result. Moreover, a kick off meeting was held in January 2021, where the 4 winners of the 1st open call explained the experiment to be developed as well as their alignment with QUALITY to other partners of the consortium.

The 4 winners of the 1st open call are:

- Piloting the Integration of BME Quality Data for In-line Autonomous Optimisation of Camshaft Hardening Processes Control (AUTOHARD)
- ZDM for flexible manufacturing based on Data analytics-driven Variation Detection and Analysis (ZDMlytics)
- imaGe Analysis for zeRo DEfect maNufacturIng in Autonomous quality for textile and cloting (GARDENIA)
- Autonomous In-line Quality Inspection Agent for Yield Optimization (Vigilant 4.0)

More information on the winning experiments can be seen in the D7.7 *SME deliverable, Cross-Border and Cross-Factory Pilots (Version 1)*

3.3 QU4LITY Assets and Requirements for 2nd OC

As in the first open call, the QU4LITY assets that the applicants of the second open call must validate have been defined (they differ very slightly from the first):

1. Technological digital enablers developed by partners of the project.
2. QU4LITY RA.

3. Autonomous QU4LITY concept as defined and developed in WP4.
4. Marketplace as defined and developed in WP8.

To be eligible for funding the applicants have to satisfy the following requirements associated to the mentioned assets:

1. Use of at least one of the digital enablers proposed by the consortium.
2. Demonstrate the alignment with the reference architecture.
3. Design aligned according to the Autonomous Quality concept.
4. Integrated into the marketplace.

In addition, applicants to type B, expansion of existing QU4LITY pilots, are required to address the challenges proposed by Riastone or Whirlpool for the second open call. Whirlpool launched a challenge for the development of a visual tool for reading and editing the data models generated in that pilot and Riastone launched two challenges: the first one to expand the coverage of the quality control and a second one to introduce product traceability during the production process.

It should be noted that the COVID-19 health crisis has delayed the work somewhat, so the open call 2 that was scheduled for January 2021, has been opened for reception of proposal on April 15th. The deadline was on June 18th with the goal of performing before summer period the evaluation process. The winning experiments of QU4LITY 2nd open call will start on September 2021.

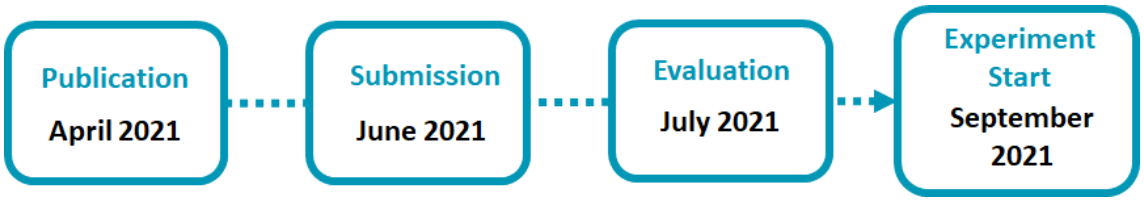


Figure 1 - 2nd Open call schedule

In the annexes to this deliverable the documents issued for the applicant to get familiar with the different assets of the project are attached. In this second open call to make it a bit easier, a document has been prepared that was not present in the first call, a catalogue with available QU4LITY enablers, this document provides information about the enabler and its use, as well as what it could be obtained thanks to him (Annex II).

3.4 Dissemination actions and results of the 2nd QU4LITY Open Call

During the timeframe April-June 2021, most of the events are virtually as a consequence of COVID-19, therefore, the dissemination of the call has been carried out exclusively online.

For this second open call INNOVALIA has reinforced the dissemination aspect. The consortium has issued 5 dedicated newsletters, two of them through the DFA. Several communications activities on social channels have been carried out and two webinars, on May, 21st and June 7th. The information has been sent to sister projects and has been published in the news section. To further increase the scope, we have participated in more than one call event organized by other projects. Finally, through the DFA, information about the call has been sent to more than 1000 contacts.

The details of the actions carried out as well as the impact generated will be reported on D9.4 "Report on the dissemination and communication (Period 3)" due to M39. The content of the webinars, attached in the annex III, is based on the documentations issued for applicants. A great advantage of the webinars held is that it allows participants to ask questions, but in any case, the support they needed has been given.

The open call closed on June 18th with the reception of **18 proposals**; **16** of them applying to the type A call (new autonomous Quality pilots) and **2** of them applying type B Call (extension on QU4LITY pilots).

The applicants come from **eleven H2020 countries**, as it can be seen in the following graph.

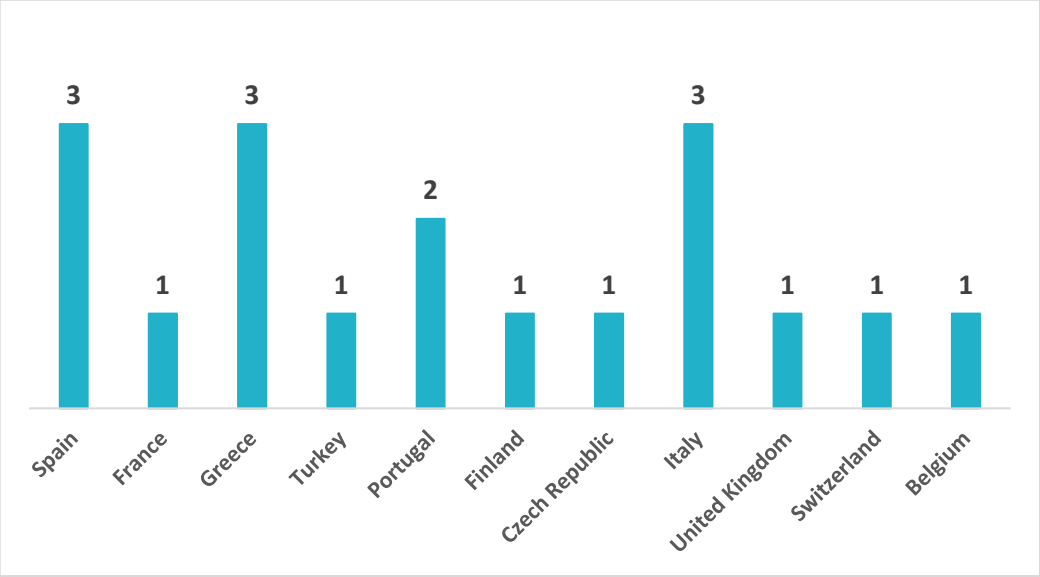


Figure 2 - Proposal received per country

Regarding Type A call, all topics have received more than one proposal except for topic A5, none of the proposals received applies it as can be seen in the following graph.

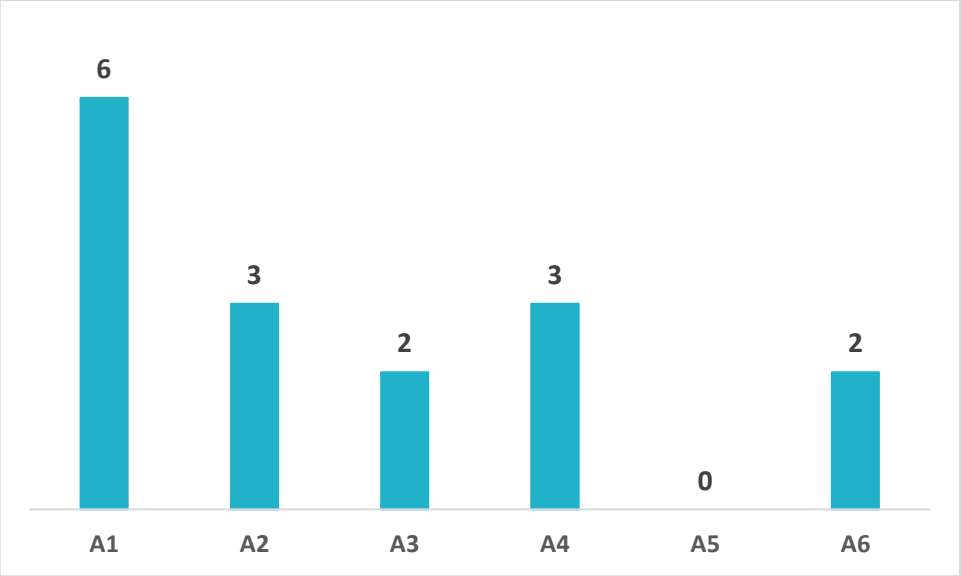


Figure 3 - Proposals received per topic (Type A)

Regarding Type B call, two proposals have been received, one for Whirlpool and one for Riastone, and none of the proposals received applies B2 challenge as can be seen below.

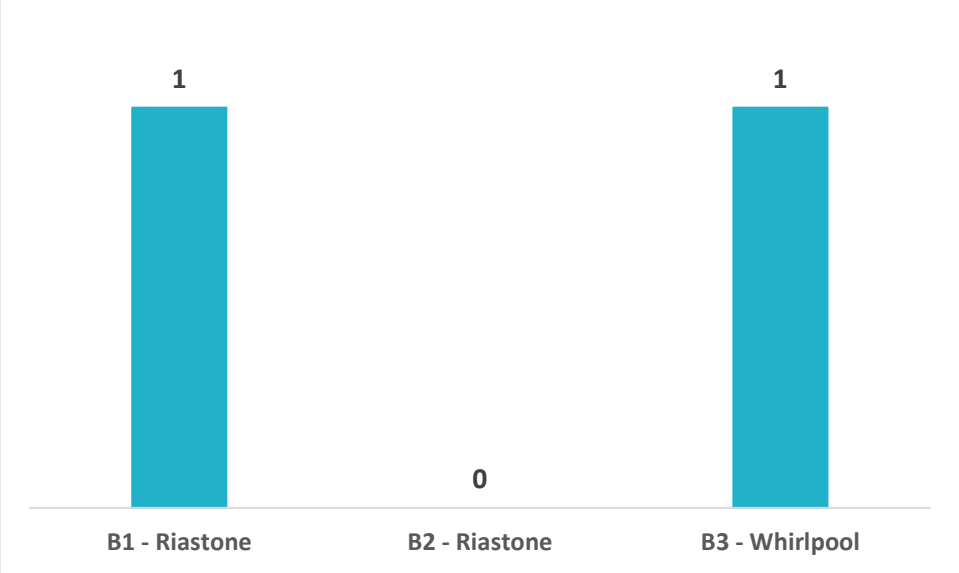


Figure 4 - Proposals received per challenge (Type B)

Currently, work is being done on the selection of external evaluators. This selection process is being carried out with the same methodology as in the 1st QU4LITY open call. That is, aspects such as the experience they have in the same sector and call

topics and the experience they have evaluating H2020 proposals are being taken into account.

Additionally, the group of external evaluators must have a good academic base, be balanced in terms of the number of men and women, and that there is representation from several countries. Finally, note that we are taking into account the work done by the evaluators in the 1st open call, to work with them again in some of the cases.

3.5 Lesson learnt

The number of proposals received on 2nd open call **is greater than in the 1st open call, this is significantly due to the increased effort put into disseminating the open call to interest groups**. Besides, analyzing the results we have learned these lessons:

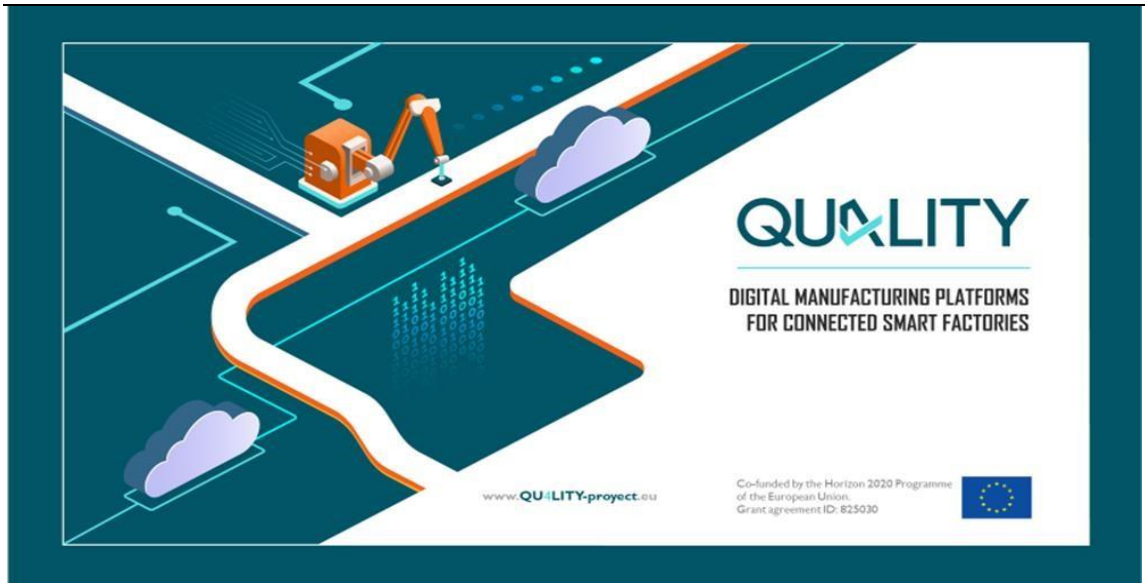
- The call is challenging for SMEs. The fact that consortia are not allowed makes it difficult for SMEs to submit proposals, since they often need the support of an RTD or consultancy company. It was something that was known from the 1st open call and it has not been possible to change it on 2nd open call, applicants allocate part of their budget to hire this type of support as a third party.
- The requirements should not be complicated or strict, in this case it is requested to use a QU4LITY enabler, integration in the marketplace and use of the reference architecture. These difficulties were also known from the 1st open call and their modification has not been possible, for that reason we have put information that is "easier" for applicants to understand, such as the enablers catalogue that can be seen in Annex II.
- More focused dissemination actions. We have learned that it is useful to use DIHs as a channel for disseminating open call, since it helps DIH to reinforce its link with its SME ecosystem through "Support to investments" service and, on the other hand, it helps to increase dissemination of the call and boosts the probability of receiving proposals.

3.6 Conclusions and next steps

In the reported period the consortium has carried out the 2nd open call of QU4LITY and started the operations for the evaluation of the received proposals. A series of lessons learnt has been extracted from the whole process taking into account the results obtained. The evaluation process must be completed before summer timer to inform the winners and start the experiments on September 2021.

The next report, at the end of QU4LITY will include the results of the evaluation of the 2nd open call

Annex I: QU4LITY Open Call 2 guide for applicants



QU4LITY 2nd Open Call

(Guidelines and Rules for Participation)

Table of Contents

1 Introduction

As part of the DT-ICT-07-2018-2019 (IA) call considerations, financial support to third parties is foreseen for the incorporation of third-parties (notably SMEs) that will take advantage of the platforms and pilots of the project and the Open APIs provided on top of them, towards enhancing the QU4LITY compliant systems (i.e. pilots/platforms) with additional functionalities and features. In particular, as listed in the call text, QU4LITY should address the following aspect: "*For large-scale piloting and ecosystem building activities, proposals may involve financial support to third parties, as explained in the introductory section 'Platforms and Pilots', to support SMEs in piloting and developing prototype applications on top of digital manufacturing platforms".*

QU4LITY will exploit this opportunity as a means of attracting SMEs in the project, as user and validators of the project's autonomous quality paradigm, but also as additional participants to the project's virtualized innovation hub and ecosystem. In particular, QU4LITY will provide financial support to SMEs that will engage in the following type of activities:

- ZDM Pilots for SME manufacturers, aiming at customizing and deploying the project's autonomous quality paradigm according to the needs of SMEs. In this direction, SMEs may take advantage of technologies developed in QU4LITY through their (Open) APIs (Application Programming Interfaces).

- Enhancements to QU4LITY digital platforms and pilots by SMEs, which will give SMEs the opportunity to further develop the project's systems using the Open APIs, the (AQ) Autonomous Quality concept and the reference architecture provided by the project.

SMEs participating in both of the above types of activities will also engage in the project's virtualized innovation hub and related market platform. Specifically, Open Call Winners will be asked to describe and make available the technologies that they will use in the project in the QU4LITY market platform. In this way the project will take advantage of the open calls processes to build its community (i.e. ecosystem building) and to establish a critical mass of participants in the project's ecosystem.

2 Objectives of the call

2.1 Context and Motivation

Any European manufacturing company has a constant need to strive for excellence. This requires producing top quality goods, being highly efficient in terms of costs and resources, while being extremely responsive to market and customer needs, and using and offering creative and innovative solutions. Moreover, there is an increasingly pressure on European industry to build sustainable, green and circular processes and products that ensure not just business goals but also societal and environmental ones for future generations – see European Green Deal[1].

However, due to increased product mass customization and the proliferation of global manufacturing networks, scalable first-time right manufacturing is becoming also increasingly complex. Products are increasingly complex, feature an increasing amount of electronics or micro-features and are increasing composed of advanced (multi-) materials - becoming stronger, lighter and smarter whilst remaining at least as safe or secure as previous versions. While a clear benefit for the end customer, such process variation is the enemy of competitiveness and profitability. It causes waste and inefficiency, leads to high quality costs and manning levels, and results in late deliveries and poor traceability. Hence, with new product features, new manufacturing processes and techniques will emerge, which in turn will call for evolution of quality control and quality assurance procedures capable to effectively deal with the inherent variability of Factory 4.0 manufacturing processes, ultimately reducing scrap levels and raising productivity.

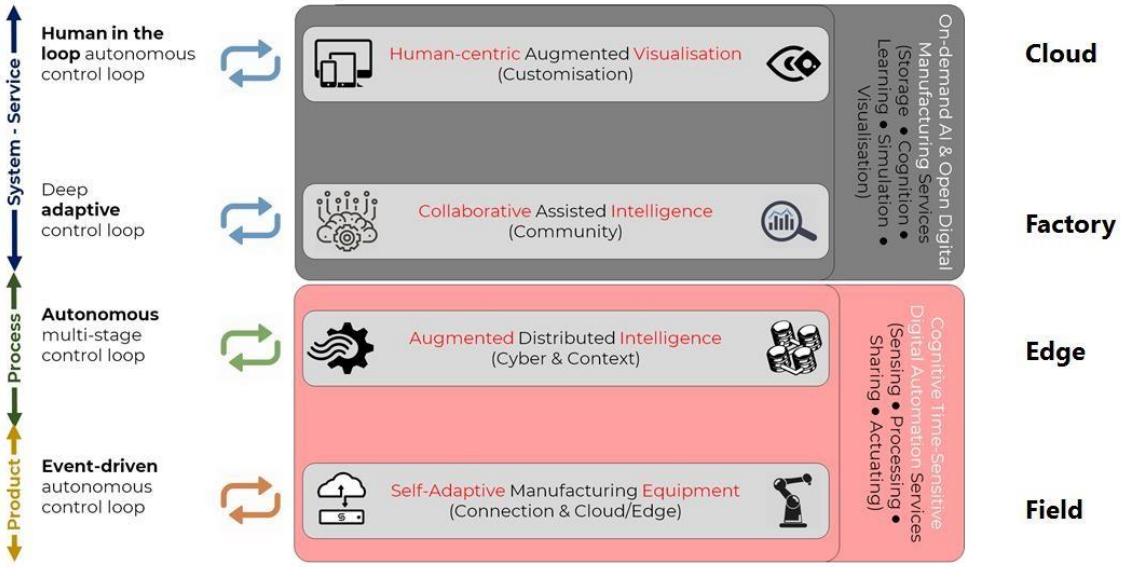
Traditional quality control models such as TQC (Total Quality Control), end-of-line SPC (Statistical Process Control) or in-line multi-stage quality control solutions are not fully capable to deal with the dynamism of such new manufacturing scenarios, calling for effective support to control smart and connected excellent and responsive production processes that combine speed, precision, quality and reliability with flexibility and agility. Manufacturing companies need to produce from very small lotsizes to big volumes and there is a growing need for the ability to quickly scale up from small to big lot-sizes whilst retaining the required quality. Traditional quality methods are rigid and still do not deliver learning and adaptation capabilities. In such connected production environments to determine the root causes or sources of variance of bad quality in supply chains is usually more difficult because multiple parties are involved in the current global manufacturing environment.

[1] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

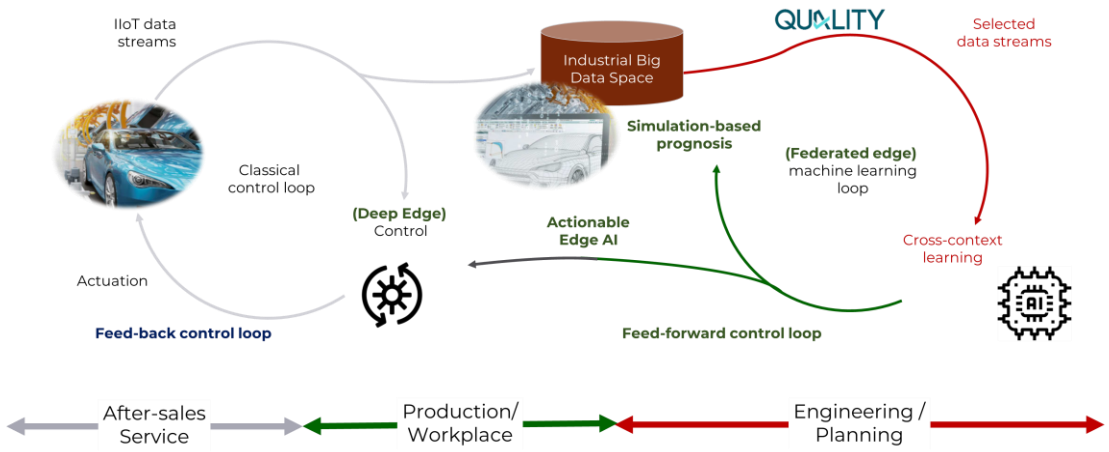
2.2 Vision

QU4LITY does not call for abandoning well established and sound quality control methods, but on the contrary calls for extending such methods with a multidimensional, multi-stage and systematic framework for cognitive collaborative quality assurance throughout an entire supply chain; i.e. autonomous quality control framework.

QU4LITY is leveraging on the modular and composable digital enablers to support the implementation of a **closed loop (feedback and feedforward) quality assurance and improvement framework to unlock the key to predictable, productive manufacturing** within which to anticipate and naturally control quality variation in the factory, backed by traceable, supply chain and process centric information view and information flow support and with innovative technology, proven methods and expert human-in the-loop support for cognitive manufacturing. Artificial Intelligence in QU4LITY is used to learn complex behaviours as perception, self-reasoning or action from experience (data acquired and simulated) in federated and privacypreserving distributed manufacturing environments, barrier that conventional Artificial Intelligence used to overcome only with expert knowledge. QU4LITY is proposing to spread intelligence across the various levels of the smart connected factory (field, edge, factory and cloud) with suitable networking, computing and analytic enablers (including visualization) that are able to meet volume, variety, velocity of decisions in the shop floor.



QU4LITY brings quality control to new levels of automation, adaptation, actuation, cognition and collaboration. The goal is to get quick, comprehensive feedback about the whole production process, looking at both the production means, the part and all of the elements contributing to manufacturing in that final workpiece.



2.3 Types of Call and topics

According to the objectives denoted above, the main financing targets for additional third parties through the QU4LITY open calls will be:

2.3.1 TYPE A: New Autonomous Quality Pilot

Calls for new autonomous quality pilots. The call will invite candidates to propose novel pilots that align to the QU4LITY autonomous quality concept, notably pilots that implement features and functionalities that are not available as part of the large-scale pilots of the consortium partners.

OBJECTIVES:

Pilots should be aligned to one or both of the following two objectives/themes:

- **Validate the QU4LITY concept, digital enablers/technologies in areas beyond the pilots of the consortium partners**: Proposers should present novel pilots in-line with the QU4LITY concept of Autonomous Quality, the QU4LITY Reference Architecture for (Digital) Zero Defect Manufacturing (ZDM).
- **Demonstrate end-to-end Autonomous quality in a cross-border supply Chain pilot**: Proposers should present digital quality management across a supply chain i.e. beyond a single industrial plant.

All pilots should contribute to:

- **Attracting SME Manufacturers and Solution Providers to the project's multi-side platform and ecosystem**: The proposed pilot solutions should be integrated in the QU4LITY marketplace and virtual innovation hub.

CONDITIONS:

- Proposal must address one of the topics listed in 2.3.2
- Proposed pilots should align to the QU4LITY Reference Architecture and Autonomous Quality concept.
- Proposed pilots should use QU4LITY digital enablers/technologies listed in 2.3.3 such as Machine Learning Algorithms and Data Collection Platforms. Nevertheless, pilots may include technologies of the proposers as soon as they align to the QU4LITY ZDM architecture.
- Pilots and their technologies should be described and become integrated in the project's market platform and Virtualized Digital Innovation Hub, based on relevant specifications provided by the QU4LITY consortium. This does not imply or require any IP transfer to the QU4LITY consortium, but rather making accessible the pilot solution through the project's market platform.

2.3.2 Topics for applicants to the Type A call

QU4LITY Type A 1 targets the development of pilots that address advanced production process and systems which incorporate AI-based solution to implement the QU4LITY value chain. The open call aims at complementing existing pilots currently running in 14 industrial companies and to expand the scope of existing digital platforms and pilots will new functionalities and features. Applicants are required to apply one or more of the digital technologies mentioned in the topics, such as AI, robotics, edge computing and others to improve quality control in any of the points of the quality value chain.

QU4LITY is looking for SMEs to provide technologies and innovations that could help European manufacturing industry in a **faster recovery from COVID-19 pandemic** with a focus both on new digital solutions for zero defect manufacturing working practices taking advantage of Qu4LITY digital continuity enabling technologies and platforms. Solutions that help reduce defects, improve product quality and reduce ramp up times are particularly welcome.

QU4LITY is looking also for experiments supporting automation and autonomy in trusted and fair procurement and manufacturing of innovative treatment, testing, monitoring of progress and protecting people in the next phases of the COVID-19 pandemic. At the same time, QU4lity Open Call would like to contribute to the recovering of the European SMEs during the next months, providing support to and fostering the development of technologies to cover particularly new zero defect manufacturing strategies in the context of: manufacturing repurposing, cost reduction, good first time production, business to business collaboration, and, more in general, development of autonomous quality solutions as a service for key sectors of European activity such as Food, Logistics, Automotive, Aeronautics, Healthcare, Life Science.

- **Topic A1: Data Driven AI for pattern recognition in Zero Defect Manufacturing for high performance product**

Pattern recognition is the process of recognizing patterns by using an Artificial Intelligence algorithm, it can be defined as the classification of data based on knowledge already acquired or on statistical information extracted from patterns or their representation. Pattern recognition is able to detect arrangements of characteristics or data that provide value information about a given system or data set.

Applicants to topic Q1 are required to design, implement and experiment data driven algorithms for pattern recognition related to Zero Defect Manufacturing for identification of defects, proactive quality control, reverse engineering for high performance products. The aim is to demonstrate the potential of this technology to improve the quality control in any of the critical point of their quality value chain and to analyse its connection and impact on the whole manufacturing process.

- **Topic A2: Data Driven AI in Human Machine Collaboration for Zero Defect manufacturing**

Partnering with machines is integral to the future of how we live and work. A new era of intelligent systems will be characterized by trust and understanding between humans and machine. This collaboration can provide many benefits. Machines or robot can assemble and consider more data points than humans, can incorporate and often provide a less biased support to decision and improve the productivity.

Applicants to topic Q2 are required to demonstrate the potential of the human machine collaboration for quality control in manufacturing, developing autonomous learning or decision-making algorithms to improve the quality in any of the critical point of their quality value chain and analyse its connection and impact on the whole manufacturing process.

- **Topic A3: Integration of Data driven inline Autonomous Quality in solutions for Zero Defect Manufacturing**

Traditional quality control models such as Total Quality Control, end-of-line Statistical process control or in-line multi-stage quality control solutions are not fully capable to deal with the dynamism of the Smart Factory Scenario scenarios, calling for effective support to control smart and connected production processes.

Data Driven inline Autonomous Quality solutions can deliver learning and adaptation capabilities to manufacturing companies that need to quickly scale up from small to big lot-sizes, or between different parts whilst retaining the required quality.

Applicants to topic Q3 are required to demonstrate the potential of the Data driven inline Autonomous Quality solution in highly flexible manufacturing scenarios to cover the whole quality value chain.

- **Topic A4: Edge and/or real time solutions for Zero defect Manufacturing**

Edge is how is known the computing infrastructure that exists close to the sources of data, such as industrial machines, industrial controllers e.g. SCADA systems, and databases aggregating data from a variety of equipment and sensors.

Applicants to topic Q4 are required to demonstrate the potential of the Data Driven edge computing enabled applications based on e.g. analytics, machine learning etc. to improve the quality in any of the critical point of their quality value chain and analyse its connection and impact on the whole manufacturing process.

- **Topic A5: Ensuring Quality Management in supply chain trough blockchain based technologies.**

Quality assurance in complex production systems is a difficult problem to tackle, given the number of parties involved in the sourcing of raw materials and parts and the extreme customization of products. Moreover, Zero Defect Manufacturing goals require that Autonomous Quality solutions are extended to the entire supply chain, possibly including logistics. This objective poses unique challenges, as it implies that some suppliers, although being autonomous businesses, are fully integrated into the control loop. Blockchain technology can help by providing a common, companyneutral data exchange infrastructure where key information can travel between all stakeholders of a process with top guarantees of provenance, integrity and transparency.

Applicants to topic Q5 are required to develop novel distributed applications to control the quality and traceability of materials and products along the supply chain and analyse their connections and impact on the whole manufacturing process.

Reference Documents specific for the topic Q5:

- D3.11 Permissioned Blockchain for ZDM (Version 1)

- **Topic A6 Integrating ZDM solutions in Mass Customization and Lot Size One Manufacturing processes**

Mass customization as a strategy that allows the production of small lots (even as small as lot size one) is becoming more and more popular and is one of the main implementations of the concept of Industry 4.0. Mass customized products, though are complex, feature a significant amount of electronics or micro-features and are composed of advanced (multi-) materials - becoming stronger, lighter and smarter whilst remaining at least as safe or secure as previous versions.

Applicants to topic Q6 are required to develop novel applications for a Zero-Defect Manufacturing through the integration of Autonomous Quality (AQ) Control Loops into Mass Customization and Lot Size One processes, using data driven technologies.

2.3.3 Qu4lity Digital enablers

Pilots proposed by applicants must address at least one of the topics listed in the section 2.3.2 and make use of one of the digital enablers listed in the following table[2].

Enabler	Description	IP Owner / Partner
RUL Prediction Solution	Deep Learning Systems for Remaining Useful Life Prediction	ATLANTIS
DLT Service: Quality Clearing House	Decentralized Workflow Management for Quality Management and ZDM scenarios in the supply chain	ENG
Interoperability converter platform	The Converters for Interoperability enables syntactic interoperability between heterogeneous systems (IoTA events and Mimosa) by means of protocol and data format translation	MON-MGEP
IDS Connector	IDS Connectors are IoT gateways for data providers and consumers as described in the DIN Spec 27070.	IDSA
Edge Computing Enablers	Edge computing solutions enable data handling at the edge of the network, directly at the machines.	TTTech
FOOTPRINT	Edge computing solution that enables a high-level monitoring of the production quality, automatic detection and identification of problems or defects during manufacturing	UNPARALLEL

RELEVANT DOCUMENTS:

- QU4LITY Deliverable D2.11 Reference Architecture and Blueprints (Version 1)
- QU4LITY Deliverable D3.5 Big Data and Analytics Infrastructure (Version 1)
- QU4LITY DeliverableD3.13 Library of Integrated, Interoperable Digital Enablers (Version 1)
- QU4LITY D8.1 Market platform and Virtualized Digital Innovation Hub

Specific to topic Q5:

- QU4LITY Deliverable D3.11 Permissioned Blockchain for ZDM (Version 1)

[2] The listo of enablers can be updated during the call, check the official documents on the submission site.

ALLOCATED BUDGET: **EUU 300,000.00**.

EUR 75,000.00 for single applicant

Each proposal must be submitted by a single applicant, consortia are not allowed.

2.3.4 TYPE B: Expansion of QU4LITY pilot systems

The objective of the TYPE B call is to expand the scope of existing digital platforms and pilots with new functionalities and features and address one or more challenges posed by Qu4lity pilots. The SMEs selected for funding will be given the opportunity to validate their solutions in the project's experimental infrastructures and testbeds.

OBJECTIVES:

Proposed solutions should align to one or both of the following two objectives/themes:

- **Validate the expandability of the QU4LITY digital platforms**: Proposers should propose and implement extensions to the QU4LITY technologies, notably to the QU4LITY platforms used in the project's pilots.
- **Complement existing pilots and platforms with added-value features and functionalities**: Proposer should propose extensions to existing pilot systems to address specific challenges posed by the pilot

Solutions should contribute to:

- **Expanding the QU4LITY ecosystem and broadening the solutions QU4LITY portfolio in the market platform**: Proposers should describe their solution and how it will be made available through the QU4LITY market platform and Virtualized Innovation Hub.

CONDITIONS:

- Solutions should align to the QU4LITY Reference Architecture.
- Solutions must address challenges raised by the Qu4lity extend existing QU4LITY Digital Platform or Pilots addressing challenges raised by the

ALLOCATED BUDGET: **EUU 375,000.00**.

EUR 75,000.00 for single applicant.

Each proposal must be submitted by a single applicant, consortia are not allowed.

2.3.5 Challenges for applicants to the Type B call

- **Topic B1: AQL/ ZDM implementation in Ceramic stoneware production (RiaStone challenge 1)**

The Riastone Pilot framework in the Qu4lity Pilot enables multiple real-time interactions in-between different production systems, so that these processes can autonomously act in face of production defects by using the Qu4lity AQL ZDM analytical loop information and automatically analyze detected product defects and accordingly adjust their machine level production settings.

The AQL ZDM analytical loop automatic production machine adjustment, is based on artificial vision inspection performed on greenware/product as they exit each production gate/stage were the AQL´s are installed,

The Qu4lity AQL ZDM systems in fact introduce a new innovative holistic management system for the inline and in-real-time management of production quality which will integrate present and future systems.

- The Riastone trial framework for the Qu4lity Pilot enables multiple real-time interactions in-between different production systems, so that these processes can act using ZDM analytical loop information and automatically adjust their production settings.
- The ZDM analytical loop automatic adjustment is be based in the quality of outgoing produce data output from previous production stages, introducing a new innovative holistic management system for the management of produce Quality management which will integrate present and future systems.

During the fulfillment of the RiaStone Qu4lity Pilot Riastone has identified two Business Scenarios, each including a complete set of ZDM Business Processes:

With the introduction of the Qu4lity ZDM-AQL systems Riastone implements two effective product Quality Control Gates in the production line on the above Business Processes

Open Call Type "B" Challenge (The Challenge)

The challenge being addressed by RiaStone for the present "OpenCall type B" is the necessity to expand coverage E2E of the Qu4lity AQL ZDM Control Gates to the 3rd main qu4lity control point in the Single firing stoneware production process

The RiaStone innovative Single Firing production process encompasses three main greenware transformation points into the final IKEA standard tableware products:

1st Process - Greenware Conformation made through the Isostatic Pressing process which, encompasses Stage 1(Greenware Conformation) & 2 (Greenware Fettling) of the conformed greenware. In this phase, the main ceramic structure (Greenware) is formed through the pressing of specific cerami paste raw matter deployed into the presses being physically formated into the IKEA designed tableware shapes.

This process is already covered in the scope of the Qu4lity Project

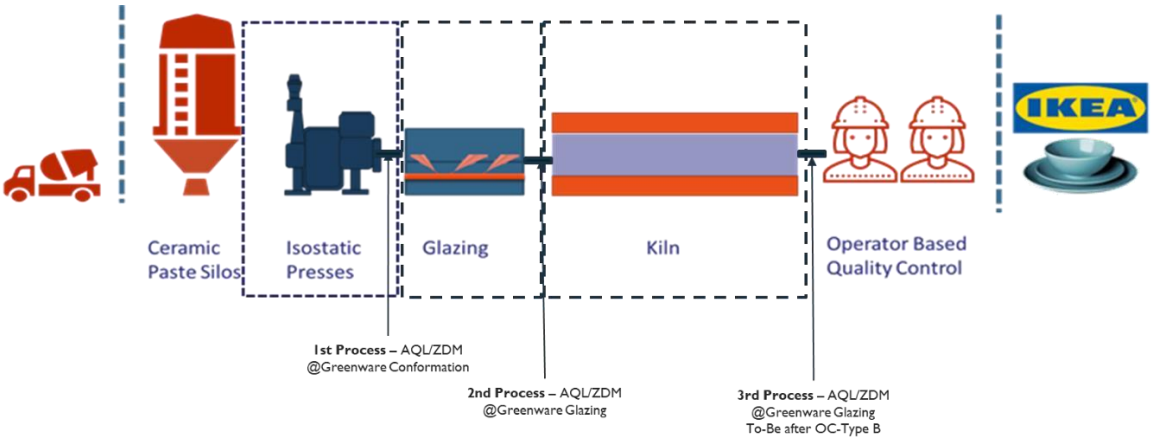
2nd Process - Greenware Glazing through the process of applying a shopfloor produced Glazing precipitate/suspension, to the conformed greenware incoming from the iso-static press lines. In this phase the conformed greenware receives an even layer application of Glaze that will give the conformed greenware, the IKEA designed Color, and after firing an even glass outer surface.

This process is already covered in the scope of the Qu4lity Project

3rd Process - Greenware Firing through the process of an automated process of greenware grouping, greenware setting, and greenware inserting, the already conformed and glazed greenware goes into a 83m long high capacity Tunnel Oven were the greenware will run through an 8 hour firing cycle, that starts at shopfloor ambient temperature, going up to 1140Cº during a plateau of 6 hours, and exiting again at the oven tunnel end, at shopfloor ambient temperature.

During the firing process the greenware main physical components (Ceramics/Glaze) undergo extreme physical stress and transformation caused by the applied heat that will physically expand and contract the tableware physical matter being fired as well as removing any solvents from the tableware. At this stage the greenware materials are taken to their physical limits, causing that any previously undetected defects will surface and cause additional production losses.

This process currently not covered in the scope of the Qu4lity Project



With the "OpenCall type B" RiaStone will cover with the Qu4lity Systems and Data Tools the Greenware firing process thus expanding coverage E2E of the Qu4lity AQL ZDM Control Gates to the 3rd main qu4lity control point in the Single firing stoneware production process

With the Open Call "B" the RiaStone Pilot will be able to expand coverage of the ZDM/AQL systems to the 3rd key business process, effectively the Single firing stoneware production process End-to-End, from raw matter to finished IKEA Goods

The Qu4lity tools and technologies to be deployed in the Open Call "B" challenge are:

a) Qu4lity Sensing technologies
b) Qu4lity - Edge Computing - FAR-EDGE Edge Analytics & Engine

c) Qu4lity Artificial Vision technologies – Dimensional inspection, and Sub-millimeter inspection

d) Qu4lity AI and Data Analytics

e) Qu4lity Decision Support ICT tools

The E2E Coverage of the complete RiaStone process will contribute towards the main business objectives of Riastone for Qu4lity implementation, namely in the axis of:

Area	Description	Measuring Unit
OPE	Increase the overall OPE KPI from 92% to 95%	% OPE Algorithm
Raw Material Reuse	Product quality improvements achieved through the new ZDM technologies in the production lines, will have a reuse rate of 70%	Units
Firing Oven efficiency	Through the use of ZDM technologies, 100% of the produce introduced in the firing oven will present no defects	Units

These are closely aligned with the main business objectives of Riastone aimed at becoming a carbon neutral Production facility, which are reflected in the three main objectives below:

1. Production cost Reduction, through the reduction of defective produce at Firing Oven Entrance
2. Product Carbon footprint reduction through diminished levels of quality rejections
3. Product Carbon footprint reduction through increased use ratio of incoming raw materials

- **Topic B2: AQL/ ZDM implementation in Ceramic stoneware production (RiaStone challenge 2)**

The Riastone Pilot framework in the Qu4lity Pilot enables multiple real-time interactions in-between different production systems, so that these processes can

autonomously act in face of production defects by using the Qu4lity AQL ZDM analytical loop information and automatically analyze detected product defects and accordingly adjust their machine level production settings.

The AQL ZDM analytical loop automatic production machine adjustment, is based on artificial vision inspection performed on greenware/product as they exit each production gate/stage were the AQL´s are installed,

The Qu4lity AQL ZDM systems in fact introduce a new innovative holistic management system for the inline and in-real-time management of production quality which will integrate present and future systems.

- The Riastone trial framework for the Qu4lity Pilot enables multiple real-time interactions in-between different production systems, so that these processes can act using ZDM analytical loop information and automatically adjust their production settings.
- The ZDM analytical loop automatic adjustment is based in the quality of outgoing produce data output from previous production stages, introducing a new innovative holistic management system for the management of produce Quality management which will integrate present and future systems.

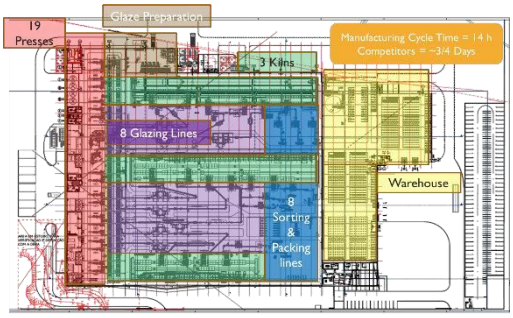
During the fulfillment of the RiaStone Qu4lity Pilot Riastone has identified two Business Scenarios, each including a complete set of ZDM Business Processes:

With the introduction of the Qu4lity ZDM-AQL systems Riastone implements two effective product Quality Control Gates in the production line on the above Business Processes

The challenge being addressed by RiaStone for the present "OpenCall type B" is the necessity to introduce product traceability in the as-is Single firing stoneware production process

RiaStone sees Traceability, as an indispensable system for the implementation of Total Quality Management in its Single Firing production process

Present Situation (as-is) the RiaStone Factory is a Greenfield in-line production facility built in 2014



The production process runs from left to right in the picture shown, this meaning from left (Raw Matter entrance), to right (final product warehousing) and the production facility employs the following number of production system elements:

- 10 x Silos for Ceramic raw Matter storage and dosing
- 19 x Iso-Static Presses for greenware conformation
- 1 x Intermediate Cure Warehouse
- 8 x Glazing Lines
- 3 x Tunnel Ovens (Kilns)
- 10 x final Quality Control Lines
- 4 x Semi-automated Packing Lines
- 1 x Storing Warehouse

The different number of shopfloor elements per each system type, is due to each system having different system cycle periods for product processing, this meaning that each one of the in-line shop floor systems has different processing cycle times per individual greenware unit.

The different numbers of each element, as well as normal daily production reprioritization, cause that the RiaStone Factory albeit being an inline factory, effectively makes that individual plate runs through the production line are made in a Divergent/Convergent mode.

The Convergent/Divergent nature of the product runs, in the production system, causes that each individual product cannot effectively be effectively traced through a traditional FIFO estimation.

Data Integration in the Shopfloor

Currently RiaStone has deployed and is deploying several different Factory data management systems, namely:

1. Industrial Big Data Systems deployed under BOOST4.0
2. Industrial AQL/ZDM Systems under Qu4lity
3. Shopfloor Manufacturing Execution Systems
4. Factory Management System

These individual systems collect, process, and analyse, massive volumes of shopfloor data resulting from the standard production processes in vertical data silos, although all separated per individual system

The introduction of an individual product traceability system at "plate" level would enable the already existing BOOST4.0 Big Data systems and Tools to perform a data integration of all systems around each individual plate as it runs through each system in the RiaStone Shopfloor until it integrates a Customer Sale Package.

Traceability System Requirements

Univocal Numbering Attribution Capability to support a continuous generation of (minimum) 21 digits per each marked plate

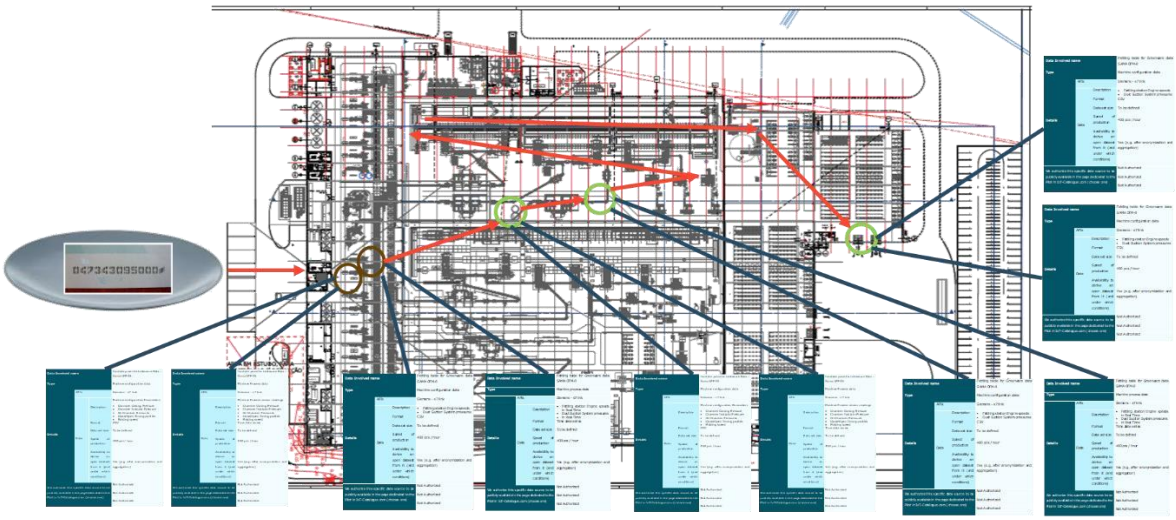
Numbering imprinting Capability to support the writing/imprint of a readable marking in Plate surface "C" (bottom center) of a 21 digits code per each marked plate, which is readable @ a minimum 5cm separation interval from plate to reader device

Numbering printing Capability of positioning, printing and releasing the greenware in a 1 second cycle.

Sightless Marking Capability to be able to effectively print the invisible marking in the plate surface, after the plate is formed in the iso-static presses, and below the applied glazing layer, assuring that at production EOL the plate has to be 100% conformant with the IKEA quality conformity standards

Extreme High Temperature Resilience to be able to survive the eight-hour oven firing cycle @1170 Cº without losing its permanent data readability features, neither becoming visible.

Capabilities that Traceability will add to RiaStone



With the implementation of Open Call "B" traceability project the RiaStone Pilot will be able to effectively integrate all systems vertical data silos around each @individual plate

The integration of all vertical data silos via the traceability project will result in:

a) Capability to perform *in the Shopfloor,* Data based defect Root Cause Analyses

b) Collect in-depth insights regarding shopfloor events @all system levels

c) Introduce in the IKEA Commercial system a complete novel feature for individual tableware pieces, IKEA traceability in Tableware is presently only performed @assembled package level

d) Incorporate new value into a mass-produced stoneware product

The introduction of Stoneware traceability @individual plate level will contribute towards the main business objectives of Riastone for Qu4lity implementation, namely in the axis of:

Area	Description	Measuring Unit
OPE	Increase the overall OPE KPI from 92% to 95%	% OPE Algorithm
Raw Material Reuse	Product quality improvements achieved through the new ZDM technologies in the production lines, will have a reuse rate of 70%	Units
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2. Product Carbon footprint reduction through diminished levels of quality rejections
3. Product Carbon footprint reduction through increased use ratio of incoming raw materials

- **Topic B3: Dryer Factory Holistic Quality Platform (Whirlpool)**

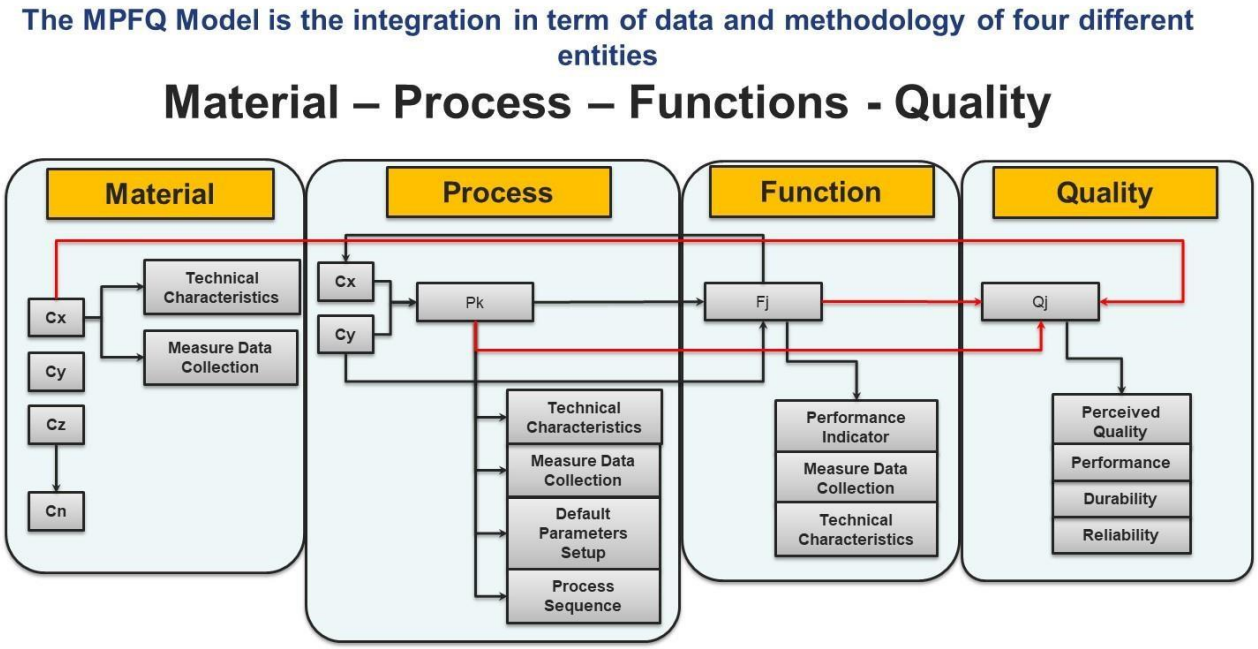
The pilot carried out by Whirlpool will integrate the QU4LITY digital enablers and platforms and the AQ (Autonomous Quality) control loops. The main innovation will be represented by the introduction in production of MPFQ (Material Process Function Quality) model fused with AQ control loops: Functional Integration and Correlation between Material, Quality, Process and Appliance Functions. This innovative way to control quality and model data inherent to quality will be the fundamental approach that will lead to the vision of holistic Quality system. Also, it will deploy AQ reference implementations to address unresolved problems in the vertical integration of data management (from data gathering to visualization and decision making), enabling a holistic vision to be achieved.

The White Good use case in QU4LITY is based on a complete production line for Dishwashing Machines and has the objectives of developing a Quality system characterized by these results:

- Common and holistic semantic model able to represent concepts at different stages of product lifecycle.
- Standard methods and tool to gather, store and share data, flexible and user-friendly.
- Analytical tools and a comprehensive way to share results to different management roles
- Addressing, at different management levels, the solution of appliance and production equipment issues, based on the analysis of the data coming from the production and testing equipment
- Automatic re-setting of the testing and production equipment parameters in order to compensate deviation in production quality

The basis of this holistic view is the semantic model which enable to create a cause – effect correlation between components, process and customer quality perception through the mediation of the physical interrelation occurring between the entities, namely the set of functions.

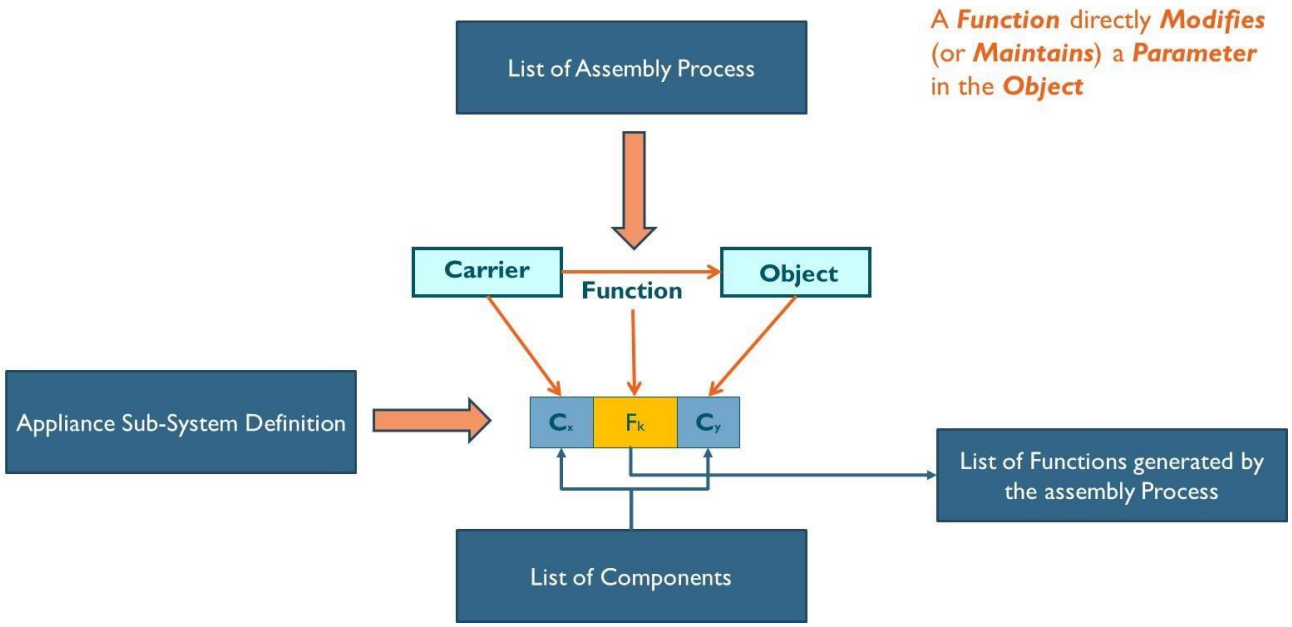
The basic syntax of this model, named MPFQ (Material, Process, Function and Quality) is represented by this diagram:



This model enables the possibility to correlate data gathered in the production (e.g results of component gauge systems, process sensors, production data, human generated data) with effective or simulated effect on Quality of the product.

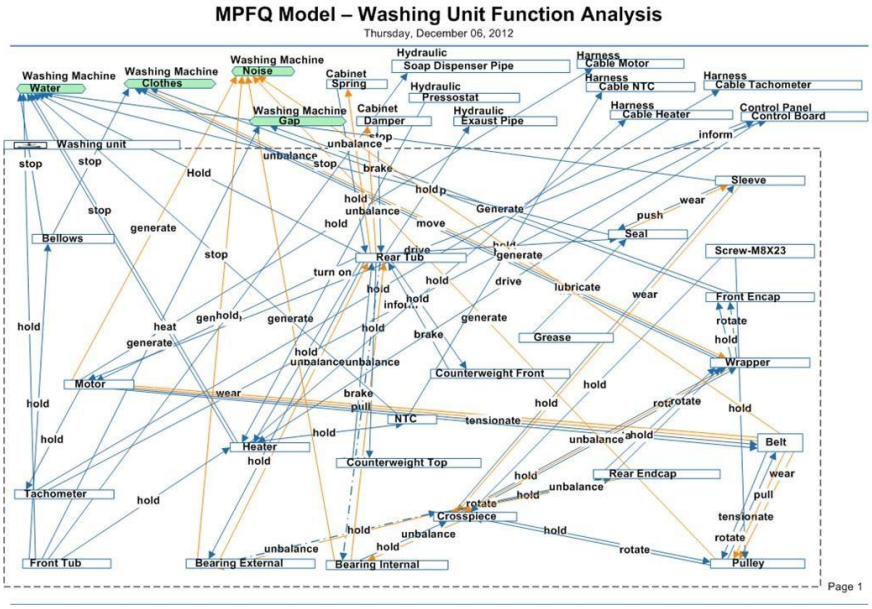
The challenge faced by the pilot that should be addressed by the applicant is related with the absence on the market of a graphical editor tool allowing industrial engineers to:

- Edit the functional model of a system of components and store the result of the graph in a machine-readable format. The graph consists in two type of elements: materials and external entities (represented by rectangles and hexagons) and functions, represented by named arrows.



- Edit the Process Map of a production system using IDEF-0 or other suitable standard representations
- Associate each Function mapped with a specific process step
- Define a set of Quality performances and associate them to a set of components, functions, process.

In the following picture a typical representation of a complex Functional model is reported:



3 Open Call Information

The announcement has been published on the portal of the European Commission and contains the main details of the topic.

Project Acronym: QU4LITY

Project full name: Digital Reality in Zero Defect Manufacturing

Grant agreement number: 825030

Call Identifier: QU4LITY OC2

Call title: Call for Proposals for pilots and digital platform in the field of Zero-Defect Manufacturing (ZDM) by SMEs and MidCaps

Publication Date: 15th April, 2021

Open for submission: 15th April, 2021

Deadline: 18th June, 2021

Expected duration of the activities: 9 Months

Total budget: € 675,000.00

Maximum funding request per proposal Type A: EUR 75,000.00 for single applicant

Maximum funding request per proposal Type B: EUR 75,000.00 for single applicant.

Project web address: https://qu4lity-project.eu/

Submission site: https://qu4lity.ems-innovalia.org/

Mail: qu4lity_opencall@innovalia.org

The submission site will be available from 21 April

A contact tool is available also inside the submission site.

4 Submission of proposals

General information

Submission deadline: All submissions must be made by 18th June at 17:00 Brussels local time

Electronic submission: Proposal submission is exclusively in electronic form using the proposal submission tool accessible via the QU4LITY open call web-site: https://qu4lity.ems-innovalia.org/

The central component of proposal submission is the uploading of a PDF-document (whose size must not exceed 5.0 MB) compliant with the instructions on the proposal structure given below.

Proposal format and structure: Proposals must be submitted in English. The main section of the proposal must not exceed 10 pages in length (with text no smaller than 11-point Times New Roman font). Thus, with the inclusion of the cover page and administrative pages (discussed below), the maximum page count is 13 pages. **Proposals will be truncated to this page count and the independent expert evaluators will only be provided with the truncated version.**

The structure of the proposal (and indicative length per section) should be as follows:

1. Summary (0.5 pages)
2. Concept and innovation (2,5 pages)
3. Industrial relevance, potential impact and exploitation plans (3 pages)
4. Description of the workplan (1 page)
5. Background and qualification (1 page)
6. Justification of costs and resources (1 page)

As indicated above, the overall length of the above 5 sections must not exceed 10 pages.

In addition to the 10-page proposal description, a cover page and 2 pages of administrative data for statistics analysis, including, if already available, the Participant Identification Code (PIC) issued by the European Commission (http://ec.europa.eu/research/participants/portal/desktop/en/organisations/register.html).

5 Proposal Evaluation and selection

5.1 Eligibility criteria

The call for third-parties support will be addressed to SMEs and Mid-Caps, as defined in the EU law: (EC recommendation 2003/361/EC as published in the Official Journal of the European Union L 124, p. 36 of 20 May 2003). All SMEs and MidCaps eligible for Horizon 2020 will be eligible to submit proposals for the open calls, except for the consortium's partners and other parties that may have conflicts of interest.

The call for third-part support will be also open to SMEs and MidCaps outside the EU, which will however have to bear their project costs.

The criteria for financial support will include:

A. The Innovation of the application (i.e. in terms of its Scientific and Technological Excellence) to be implemented/integrated based on QU4LITY,
B. Its impact on the QU4LITY ecosystem and its contribution to meeting QU4LITY's goals and objectives. Alignment to the Conditions and Objectives outlined above in Section 2 will be considered as part of this Criterion.
C. The ability of the SME and MidCaps to implement the experiments and/or integrate its new services, based on the proposer's team and company profile, background infrastructures, experience, but also based on its proposed implementation plan.

The financial support will be given upon presentation of specific deliverables by the selected partners. Each proposal must be submitted by a single applicant, consortia are not allowed

5.2 Evaluation criteria

The ranking of selected projects will be created assessing the following criteria:

- **Excellence and innovation**: The Innovation of the application (i.e. in terms of its Scientific and Technological Excellence) to be implemented/integrated based on QU4LITY-

- **Impact including industrial relevance and business strategy**: Its impact on the QU4LITY ecosystem and its contribution to meeting QU4LITY's goals and objectives.

- **Implementation and deployment of resources**: The ability of the proposer to implement the experiments and/or integrate its new services, on the basis of the team and company profile, background infrastructures, experience, but also based on its proposed implementation plan.

Evaluation scores will be awarded for each of the criteria. Each criterion will be scored out of 5 and decimal numbers can be given. The second criterion, Impact and Industrial relevance, will have a threshold of 4, while for the first and last a threshold of 3 will apply. The overall threshold, applying to the sum of the four individual scores, will be 15. If two or more proposals are tied with the same overall score, priority will be given as illustrated in Table 2 below

Criterion	Priority if ex aequo	Threshold
Excellence and innovation	2	3/5
Impact including industrial relevance and business strategy	1	4/5
Implementation and deployment of resources	3	3/5

5.3 Evaluation process

External experts who will be appointed and approved by the QU4LITY consortium will be in charge of selecting the third parties that will develop new solutions over the QU4LITY software and pilot infrastructure.
Each proposal will be assessed according to the three criteria presented in Section 5.2, through the usual 0 – 5 score scales for H2020:

- 0: The proposal fails to address the criterion under examination or cannot be judged due to missing or incomplete information;

- 1 (Poor): The criterion is addressed in an inadequate manner, or there are serious inherent weaknesses;
-
- 2 (Fair): While the proposal broadly addresses the criterion, there are significant weaknesses;
-
- 3 Good The proposal addresses the criterion well, although improvements would be necessary;
-
- 4 (Very good): The proposal addresses the criterion very well, although certain improvements are still possible;
-
- 5 (Excellent): The proposal successfully addresses all relevant aspects of the criterion in question.

The final approval of the selected third parties to receive financing will be done by the PCT, considering the best fit to the specific project objectives and possible conflict of interest issues.

6 Funding and reporting

6.1 Eligible costs

Eligible costs consist of

- Personnel Costs
- Equipment Costs
- Travel expenses
- Software licenses
- Subcontracting
- Indirect cost (25% of direct costs)

The funding of Third Parties must follow the same principles as used for existing project beneficiaries of Qu4liyt, which receives European Commission funding as an "Innovation Action". Thus, Third Parties will receive 70% funding of eligible costs arising.

6.2 Reporting and deliverables

The administrative tasks for the funded third parties including cost and activity reporting obligations and related templates will be provided during the negotiation and contracting phase. Qu4lity will apply the pilot maturity levels methodology in the implementation of the selected projects.

Funded third parties will be requested to submit several deliverables to demonstrate the reached maturity level according to Table 3.

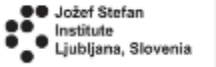
Status of development	Timing	TYPE A Deliverables	TYPE B Deliverables
Pilot Maturity Level 1	M2	Proof of concept Alignment with the reference architecture Alignment with the Qu4lity Autonomous Quality concept M2 cost statement	Proof of concept Alignment with the Qu4lity Autonomous Quality concept Integration strategy in the reference pilot M2 cost statement
Pilot Maturity Level 2	M7	Complete development of the pilot Demo and dissemination material (video, ppt) Participation to demo event organized by the consortium	Complete development and integration in the Q of the pilot Demo and dissemination material (video, ppt) Participation to demo event organized by the consortium
Pilot Maturity Level 3	M9	Business model Integration in the Quality marketplace Business Plan M9 cost statement	Business model Integration in the Quality marketplace Business Plan M9 report

6.3 Funding Scheme

The following payment scheme will apply:

- Max 20% of the budget, according to cost statement, at M2, once the third party has produced all the relevant documentation specified in the contract, in particular cost statements for the period and deliverables, as indicated in Section 6.2 and the contractor (Innovalia), after discussion with the consortium, has accepted them
- Max 60% of the budget, according to cost statement, at the end of the project on M9, once the third party has produced all the relevant documentation specified in the contract, in particular cost statements, deliverables and material for dissemination, as indicated in Section 6.2 and the contractor (Innovalia), after discussion with the consortium, has accepted them. Moreover, the participation to an event for dissemination purpose is mandatory.
- Max 20% of the budget, according to cost statement, at the final installation approval of the pilots' outcomes by the Commission

Partners



Annex II: Digital enablers Catalogue

DIGITAL MANUFACTURING PLATFORMS FOR CONNECTED SMART FACTORIES

Open Call 2

ENABLERS

Table of Contents

1 Interoperability converter platform (MON-MGEP)

Name the enabler
Interoperability converter platform
Main functionalities
The Converters for Interoperability enables syntactic interoperability between heterogeneous systems (IoT-A events and Mimosa) by means of protocol and data format translation. It is composed of three parts: 1) An infrastructure solution composes of three servers, 2) A number development tools and guidelines and; 3) The converters constructed for the APIs. The infrastructure part of the middleware platform for interoperability to be built in this task will consist of a Docker solution with three servers: 1. An Enterprise Service Bus (ESB) server that enables the deployment of software artefacts for the conversion of data between APIs, IoT gateways and platforms; 2. An edge broker server for message publication and subscription. This broker enabled event driven architectures for the converters that need to integrate APIs that need such infrastructure; 3. A Node-RED server is also provided. Node-RED has similar integration capabilities to those of WSO2; Potential Applications As a converter between different IoT Gateways and platforms. To be included in any platform as an OT to IT convertor (for example OPC-UA to publish-subscribe)
Compatibility with the topics of the QU4LITY open call

TYPE "A" TOPICS	
Q1: Data Driven AI for pattern recognition in Zero Defect Manufacturing for high performance product	
Q2: Data Driven AI in Human Machine Collaboration for Zero Defect manufacturing	

Q3: Integration of Data driven inline Autonomous Quality solution solutions for Zero Defect Manufacturing	✓
Q4: Edge and/or real time solutions for Zero defect Manufacturing	
Q5: Ensuring Quality Management in supply chain trough block chain	
Q6: Integrating ZDM solutions in Mass Customization and Lot Size One Manufacturing processes	

Main benefits for the user

Improved interoperability among systems

Infrastructure available in Docker technology (easy deployment)

Open-source solution

Converters customize to specific protocol/communication system requirements

Fields of applications

Interoperability for REST API, Event Driven solutions, OPC-UA …

Scenarios of Use:

- Input:

The enabler provides the infrastructure to build converters that need to be customized to the conversion requirements. Architectures: REST API, Event Driven solutions, OPC-UA … Formats: JSON, XML, CSV …

- Output:

An interoperability platform to adapt third party protocols to company's needs.

2 IDS Connector (IDSA)

Name the enabler
IDS Connector
Main functionalities
IDS Connectors are IoT gateways for data providers and consumers as described in the DIN Spec 27070. Connectors can be integrated into sensors of machines on the shop floor as well as into entire IT Systems. One of the major benefits of sharing data via an IDS Connector is data sovereignty for the provider. The provider can define rules, like e. g. "read only", "access only for third parties from Europe", "no access after accessing the data set 5 times", etc. On the side of the consumer of data these rules can be technically enforced which adds another layer of trust in addition to legal contracts that enforce policies. The benefit of this is obvious in data exchange scenarios between different companies, but it also can add value to company internal data exchange by eliminate company internal data silos.
Compatibility with the topics of the QU4LITY open call

TYPE "A" TOPICS	
Q1: Data Driven AI for pattern recognition in Zero Defect Manufacturing for high performance product	✓
Q2: Data Driven AI in Human Machine Collaboration for Zero Defect manufacturing	✓
Q3: Integration of Data driven inline Autonomous Quality solution solutions for Zero Defect Manufacturing	✓
Q4: Edge and/or real time solutions for Zero defect Manufacturing	✓
Q5: Ensuring Quality Management in supply chain trough block chain	✓
Q6: Integrating ZDM solutions in Mass Customization and Lot Size One Manufacturing processes	✓

Main benefits for the user
Full control over data set that is shared via IDS Connector. Data can be shared (depending on policies) with every other participant in the same data space.
Fields of applications
he approach is agnostic from domains or specific scenarios and can be applied to any use case where sharing of data is essential.
Scenarios of Use:
- Input:
Please describe which information a manufacturing company should provide, what format they should use Every kind of data set (data series, batch data) can be shared in a format of choice. The only prerequisite is the semantic labelling of data according to the IDS Information Model. The information model is a top-level ontology that does not contain any domain specific labels. The domain specific labelling is left to the use case that must select domain specific ontologies on their own.
- Output:
Improve efficiency in the supply chain, e.g. SCSN use case or SICK use case Predictive maintenance, e.g. for wind turbines Leverage AI Services, for example for new product development (as in KI Marktplatz). More information on how IDS fosters the success of AI: article on the IDSA website. Optimisation, e.g. Optimizing Equipment Selection in the Metal Manufacturing Domain

3 Edge Computing Enablers (TTTech)

Name the enabler
Edge computing enablers
Main functionalities
Edge computing solutions enable data handling at the edge of the network, directly at the machines. Edge solutions can collect, store and analyse machine data direct on the edge device without having to send the data into the cloud. Through the use of virtualized environments, multiple applications can be consolidated on a single device, also supporting legacy systems. Additionally, edge devices will have access to a management system, where the solutions deployed worldwide can be managed from a single location.
Compatibility with the topics of the QU4LITY open call

TYPE "A" TOPICS	
Q1: Data Driven AI for pattern recognition in Zero Defect Manufacturing for high performance product	
Q2: Data Driven AI in Human Machine Collaboration for Zero Defect manufacturing	
Q3: Integration of Data driven inline Autonomous Quality solution solutions for Zero Defect Manufacturing	
Q4: Edge and/or real time solutions for Zero defect Manufacturing	✓
Q5: Ensuring Quality Management in supply chain trough block chain	
Q6: Integrating ZDM solutions in Mass Customization and Lot Size One Manufacturing processes	

Main benefits for the user

Northbound connection to various cloud solutions

Southbound connection directly to the machines for collecting data and controlling actuators

(Legacy) Application hosting using virtualized environments

(Real-time) data handling

Remote access and configurability of the devices

Fields of applications

Manufacturing, machine builders

Scenarios of Use:

- Input:

Please describe which information a manufacturing company should provide, what format they should use

What data sources will be connected to the edge solution (PLCs, sensors, field busses, databases, actuators, etc.)?

What data will be stored on the edge?

Which data needs to be processed at the edge?

Where should the data be transferred (e.g. cloud, system manager, external database, etc.)?

What kind of applications are supposed to run on the edge and what are the requirements for these applications (e.g. Linux, Docker, virtual machines, Windows)?

Will the edge device function as PLC/what is being controlled?

- Output:

Please describe what the manufacturing company will get after the use of the enabler.

The edge devices are infrastructures for hosting ZDM applications, thus at the end it depends on the applications running on the edge devices what kind of output will be provided. Edge devices enable manufacturing companies and machine builders to have access to the data and perform the handling of the data at the edge of the network.

4 Quality Clearing House (ENG)

Name the enabler
Quality Clearing House (QCH)
Main functionalities
QCH enables a decentralized workflow that targets a typical Quality Management / ZDM process in a non-hierarchical supply chain scenario. It provides a common "system of record" for a manufacturing ecosystem where actors need to continuously assess the quality of raw material, parts and final products and match the results against contractual standards that may change frequently. Thanks to distributed ledger technology, QCH records are secure and trustworthy: they are timestamped, immutable and non-repudiable. Data storage and business logic are replicated on all the nodes of the system, which are operated equally by all participants, so that no single "owner" of the system exists who may introduce bias in the process.
Compatibility with the topics of the QU4LITY open call

TYPE "A" TOPICS	
Q1: Data Driven AI for pattern recognition in Zero Defect Manufacturing for high performance product	
Q2: Data Driven AI in Human Machine Collaboration for Zero Defect manufacturing	
Q3: Integration of Data driven inline Autonomous Quality solution solutions for Zero Defect Manufacturing	
Q4: Edge and/or real time solutions for Zero defect Manufacturing	
Q5: Ensuring Quality Management in supply chain trough block chain	✓
Q6: Integrating ZDM solutions in Mass Customization and Lot Size One Manufacturing processes	

Main benefits for the user
Blockchain technology is a key enabler of trust in scenarios where different autonomous organizations must cooperate on a process.
Fields of applications
Any supply chain ecosystem where Quality Management is a collaborative process with multiple stakeholders.
Scenarios of Use:
- Input:
Quality Assessment Data Model (QADM): a structured digital document that defines the standard of quality that applies to a given material, part or product, as stipulated by a commercial agreement (which is out of this scope). The standard is expressed in terms of a list of measurements, each consisting of a qualitative definition and a quantitative range. One QADM document may exist for the entire duration of a contract, or new versions may be created that override previous ones in order to follow along the evolution of quality requirements. Shipping Unit Manifest (SUM): a digital record that identifies a shipped batch of materials, parts or products as subject to a given quality agreement. It consists of a pointer to an existing QADM and of a list of IDs, each associated to a physical item in the batch. Quality Assessment Report (QAR): a digital record that reports the quality measurements taken on a received batch of materials, parts or products, along the guidelines of their agreed standard. It consists of pointers to an existing QADM and SUM, plus the actual values of all the measurements taken. Depending on the quality agreement in place, measurements may be reported per-batch (average values) or per-item.
- Output:
QCH provides a trustworthy, timestamped and immutable ledger of digitally-signed QADM / SUM / QAR input entries, which is replicated on all the nodes of the blockchain system.

5 Footprint (Unparallel)

Name the enabler:
FOOTPRINT (Edge computing enablers)
Main functionalities
Edge computing solution that enables a high-level monitoring of the production quality, automatic detection and identification of problems or defects during manufacturing. It uses voltage and current sensors to create energy profiles, for a machine doing a specific job. The edge devices connect to a remote management system that provides, remote access to the device and remote data storage.
Compatibility with the topics of the QU4LITY open call

TYPE "A" TOPICS	
Q1: Data Driven AI for pattern recognition in Zero Defect Manufacturing for high performance product	✓
Q2: Data Driven AI in Human Machine Collaboration for Zero Defect manufacturing	
Q3: Integration of Data driven inline Autonomous Quality solution solutions for Zero Defect Manufacturing	
Q4: Edge and/or real time solutions for Zero defect Manufacturing	✓
Q5: Ensuring Quality Management in supply chain trough block chain	
Q6: Integrating ZDM solutions in Mass Customization and Lot Size One Manufacturing processes	

Main benefits for the user

Remote access and configurability of the devices

Real time monitoring of energy parameters

Easy access to historical data

Automatic detection of faults

Predictive maintenance forecast

Fields of applications

Manufacturing, machine builders, industrial production pipelines

Scenarios of Use:

Quality control services applied on each machine of an industrial production pipeline

- Input:

○ Current sensors ○ Voltage sensors ○ Timestamped annotations (e.g., Machine job o action, fault identification)

To train the pattern recognition models, besides the current and voltage sensor data, it is needed to know what job or action the machine was performing, and what faults might have occurred, to allow matching the energy profiles with a job, action, or fault. At an initial stage, the edge device is deployed to collect the energy parameters needed to model the machine's energy profile. Then the models can be trained, using the collected sensor data together with the timestamped annotations, provided by the manufacturing company.

What data sources will be connected to the edge solution (PLCs, sensors, field busses, databases, actuators, etc.)?

Voltage and current sensors ○ External databases

What data will be stored on the edge?

Current, voltage, power, energy, frequency, cos phi, and recognized patterns.

Which data needs to be processed at the edge?

Sensor data is processed with pattern recognition models to detect machine's jobs, actions, and faults.

Where should the data be transferred (e.g. cloud, system manager, external database, etc.)?

The measured sensor values and recognized patterns are stored on an external database and an internal database.

What kind of applications are supposed to run on the edge and what are the requirements for these applications (e.g. Linux, Docker, virtual machines, Windows)?

The edge device runs Linux

- ✦ Sensor acquisition scripts (GO)

Database connectors (MQTT)

Pattern recognition algorithms (TensorFlow)

- Will the edge device function as PLC/what is being controlled?

The device will not perform any direct control on the monitored machine. The sensors are read in real time and the recognized patterns generate events or alarms that can be used by a PLC, or other device controlling the machine, to trigger the desired actions.

- Output:

Measured parameters:

Current

Voltage

Power

Active power

Reactive power

Apparent power

Energy consumption

Energy production

Power consumption

Power production

Frequency

Cos Phi

Pattern recognition:

Machine job

Fault detection

Maintenance forecast

The edge device provides energy monitoring and detection of the machine's job or action based on the energy profiles used to train the model. Additionally, automatic detection and identification of problems or defects during manufacturing and maintenance forecasts can also be supported.

The measured parameters are read out every second and sent to the configured MQTT broker, for storage of historical data in an external database. The data is also stored in an internal database every minute, which is convenient in case of offline usage. The measurement periods can be configured if needed. In addition, it provides a dashboard, built with Grafana, to view historical data and export CSV files, to allow usage of the datasets with other tools.

6 Deep Learning Systems for Remaining Useful Life Prediction (ATLANTIS)

Name the enabler:
Deep Learning Systems for Remaining Useful Life Prediction
Main functionalities
The Remaining Useful Life (RUL) metric refers to the predicted time till the occurence of an asset failure or the violation of the standard quality of its end product (i.e. the point at which produced parts start to have lower quality than that expected). Within the QU4LITY project, a data-driven approach based on Neural Networks and pattern matching techniques is provided for the RUL estimation of critical components. The approach relies on historical data for the model training and on real-time data for its online evaluation. The added value of the selected method (i.e. algorithm) is based on its inherited capability to identify relationships both among various sensor measurements and from different points of time; thus, addressing the challenge of long-term dependencies. A pattern matching technique is utilised to identify product cycles to train models capable of reporting reliable time-independent results. RUL enabler provides valuable information regarding the deterioration rate of the asset, contributes to the avoidance of any quality issues in the manufacturing plant, enables informed planning of maintenance activities for the asset, and minimizes negative impact on productivity. In simple words, it gives the manufacturing company time to schedule stops, avoid major failures and reduce downtime.
Compatibility with the topics of the QU4LITY open call

TYPE "A" TOPICS	
Q1: Data Driven AI for pattern recognition in Zero Defect Manufacturing for high performance product	✓
Q2: Data Driven AI in Human Machine Collaboration for Zero Defect manufacturing	
Q3: Integration of Data driven inline Autonomous Quality solution solutions for Zero Defect Manufacturing	
Q4: Edge and/or real time solutions for Zero defect Manufacturing	

Q5: Ensuring Quality Management in supply chain trough block chain	
Q6: Integrating ZDM solutions in Mass Customization and Lot Size One Manufacturing processes	

Main benefits for the user
Prediction of the next hardware or quality failure allows, with an adequate level of uncertainty, for the optimisation of production schedule and maintenance schedule. Avoidance of failures and breakdowns is of outmost importance for the manufacturers, since these incidents do not only affect the availability of equipment and production lines, but they also affect the health and deterioration status of the machines. Areas you can expect benefits in: Reduction of operation and maintenance costs; Increase of productivity; Increase of Remaining Useful Life of assets; Reduction of downtime; Increase of MTBF (Mean Time Between Failures); Reduction of MTTR (Mean Time To Repair).
Fields of applications
Identification of defects towards Zero Defect Manufacturing Quality control
cenarios of Use: Applicants are required to demonstrate the potential of the enabler to ensure improved quality of produced parts as well as increased quality in any other critical points of the value chain.
- Input:

Please describe which information a manufacturing company should provide, what format they should use

Provision of access in historical sensor measurements and failure logs from the shop-floor is expected. In brief, information expected from an applicant includes:

Real-time sensor data;

Historical data;

Log files with previous hardware or quality faults (Fault and timestamp), in order to train the algorithms (link sensorial data with faults);

Correlation between faults and signals.

For the training process, historical sensorial data along with maintenance and/or quality logs need to be available for the analysis. A generic approach for data fetching is offered through the tool, however custom data transfer bridges can be developed with any available data handling system installed on premises, in order to provide streams of data

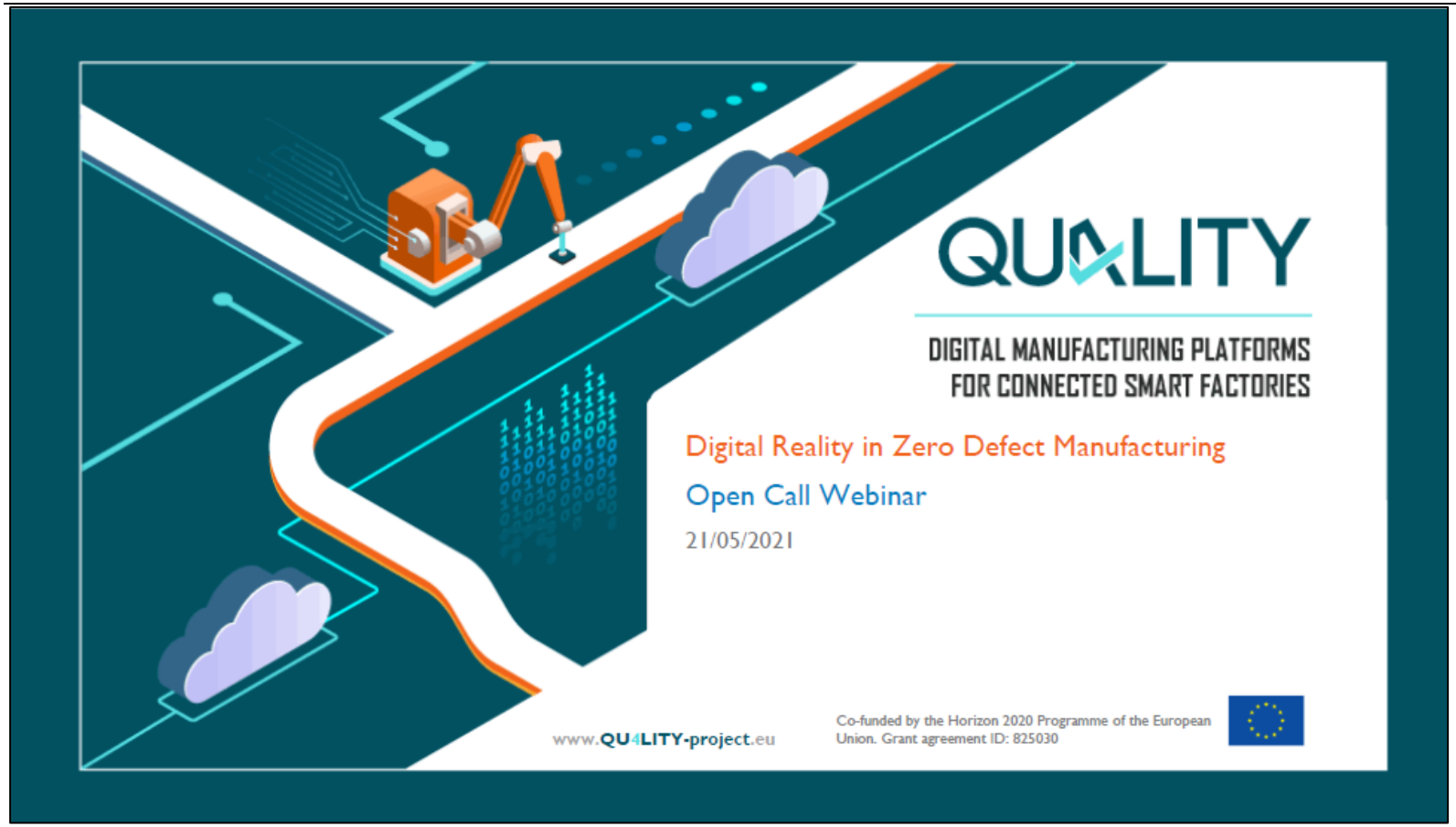
to the tool for the online evaluation of the RUL.

- Output:

Please describe what the manufacturing company will get after the use of the enabler.

The RUL enabler is provided as a dockerized solution, which can be deployed either on premises or on a remote location. Default parametrisations for model training will be provided, however custom solutions can be built through mentoring.

Annex III: Webinar presentation



QU4LITY

Introduction to the Qu4lity project

Project No:	825030
Project Full Name:	Autonomous Quality Platform for Cognitive Zero-defect ManUfacturing 4.0 Processes through DigitaL ContInuity in the ConnecTed FactorY of the Future (QU4LITY)
Duration:	39 months
Start date:	January 1st 2019
Partnership:	45 partners, 13 countries
Strategic Objective:	DT-ICT-07 (Digital Manufacturing Platforms for Connected Smart Factories)
Total Eligible Cost:	19 520 535.28 EURO
EC Contribution:	15 998 180.54 EURO (1 M€ open call)

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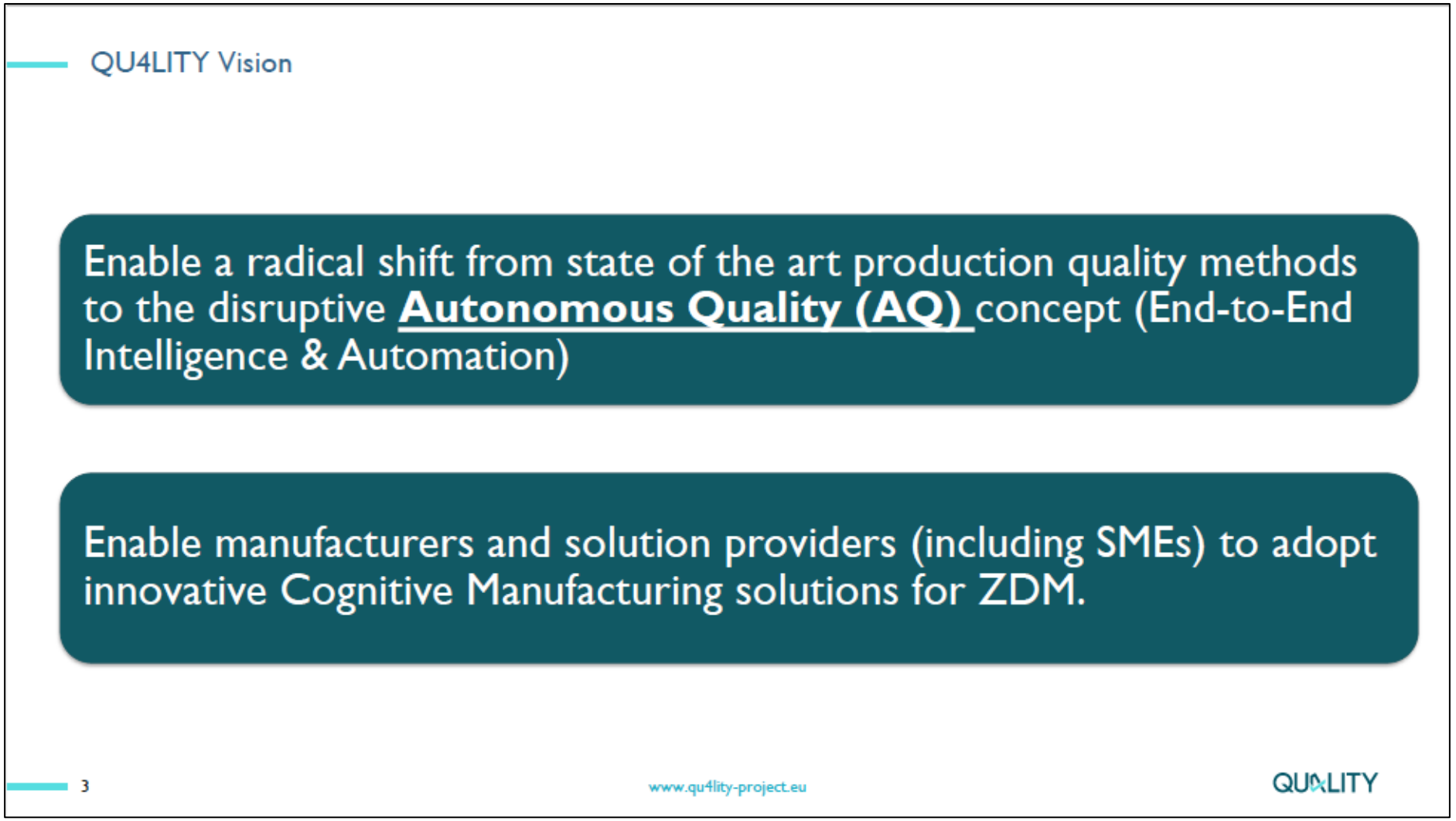


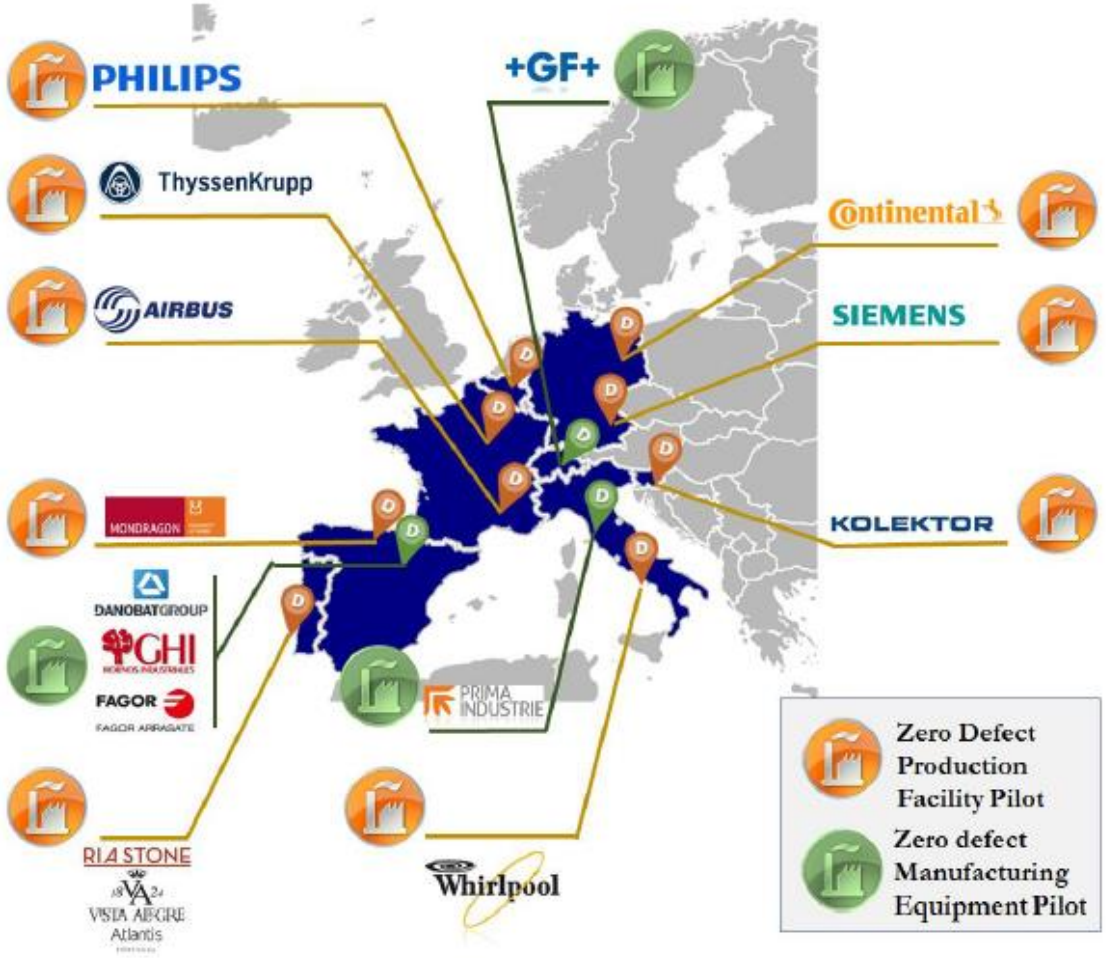
FACTORIES 4.0

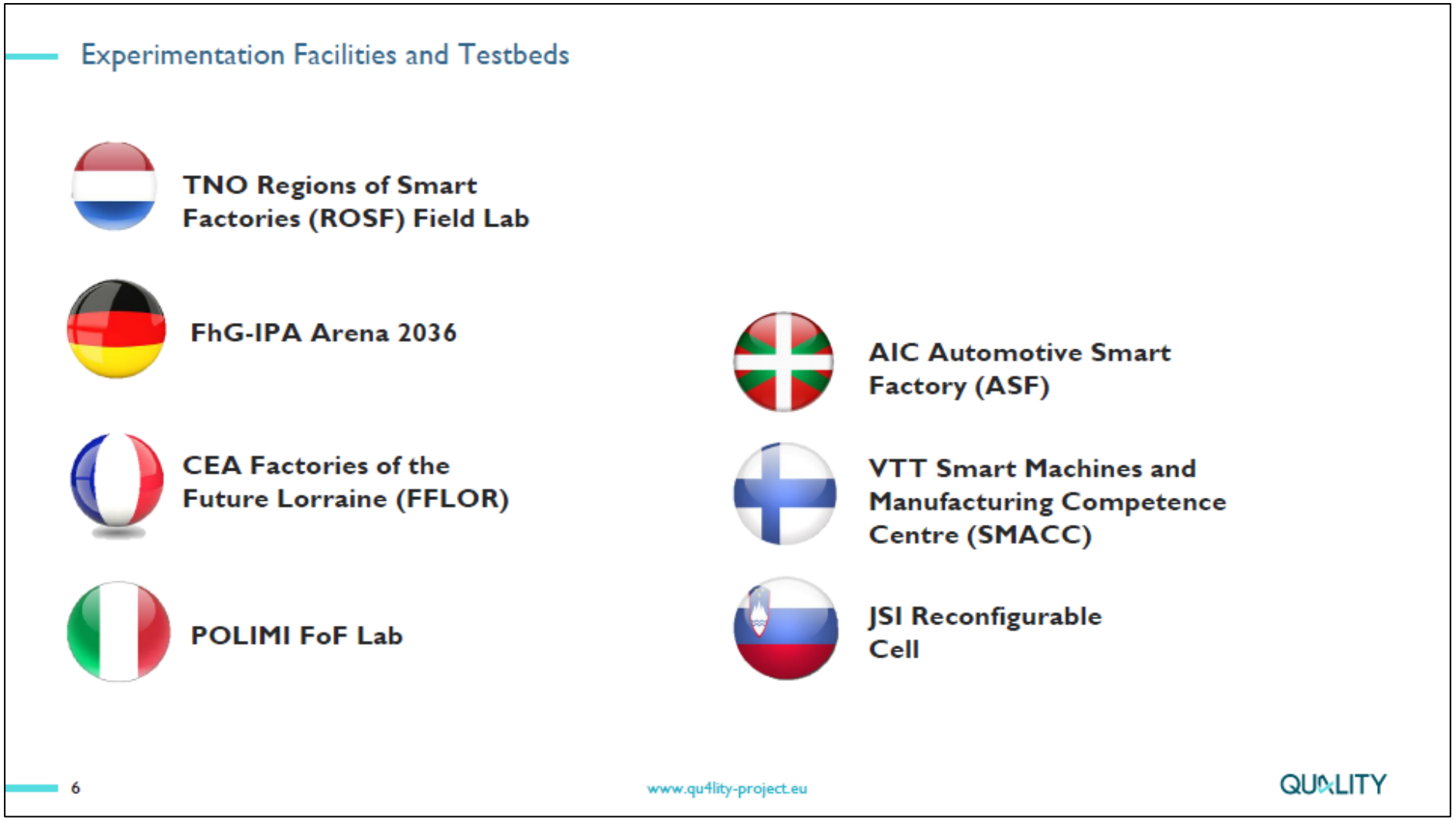
9 ZDM Pilot Factories

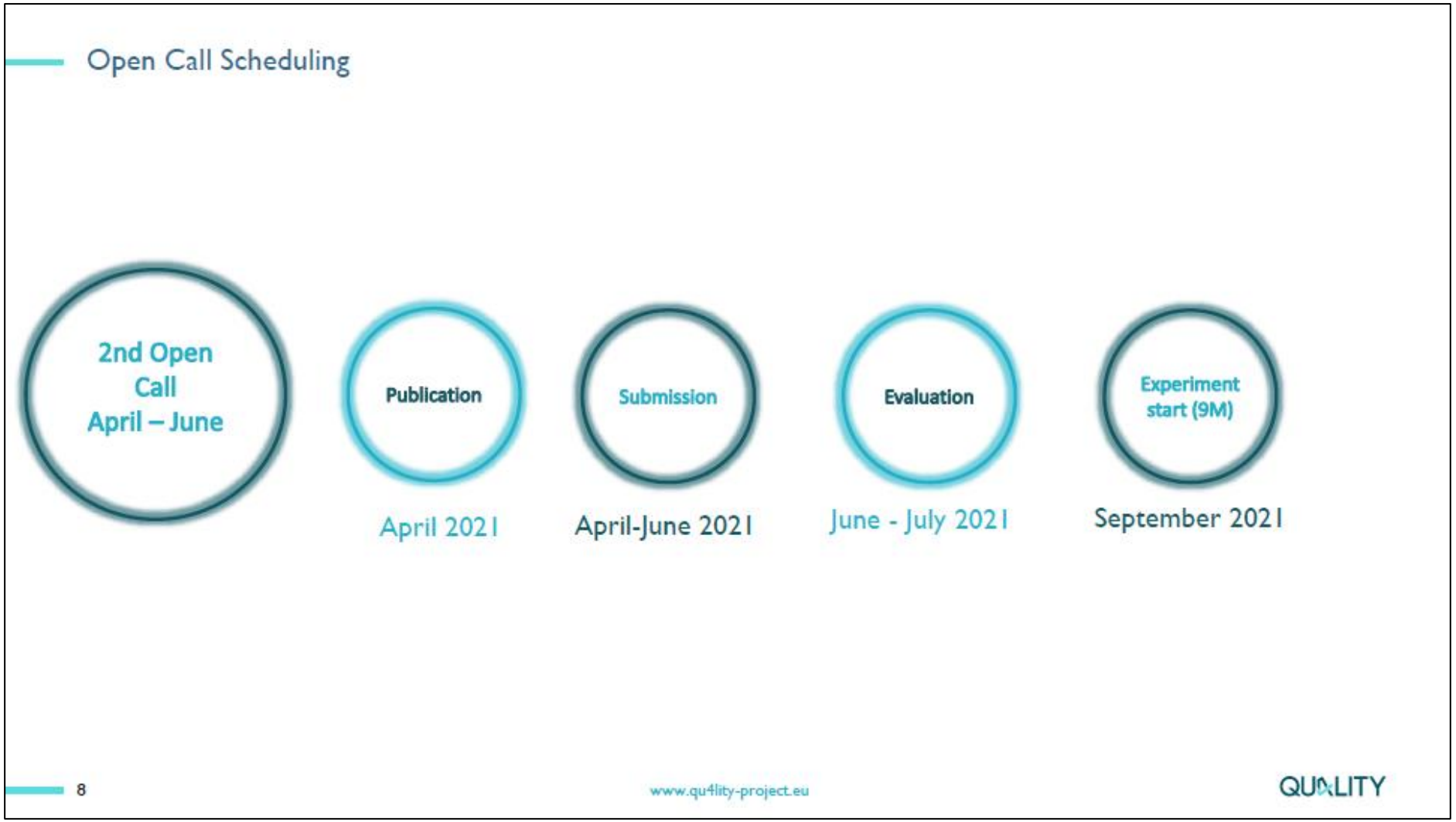
Automotive & electronics (4)
White Goods & Appliances (2)
Aero (1)
Railway (1)
Ceramics (1)

5 ZDM Equipment Pilots

Milling machines
AGVs
Stamping Press
Additive Manufacturing/Laser Systems
Industrial Furnace







TYPE A: New Autonomous Quality Pilot

Calls for new autonomous quality pilots . The calls will invite candidates to propose novel pilots that align to the QU4LITY autonomous quality concept, notably pilots that implement features and functionalities that are not available as part of the large- scale pilots of the consortium partners.

OBJECTIVES:

Pilots should be aligned to one or both of the following two objectives/themes:

Validate the QU4LITY concept, digital enablers/technologies in areas beyond the pilots of the consortium partners: Proposers should present novel pilots in-line with the QU4LITY concept of Autonomous Quality, the QU4LITY Reference Architecture for (Digital) Zero Defect Manufacturing (ZDM).

Demonstrate end-to-end Autonomous quality in a cross-border supply Chain pilot: Proposers should present digital quality management across a supply chain i.e. beyond a single industrial plant.

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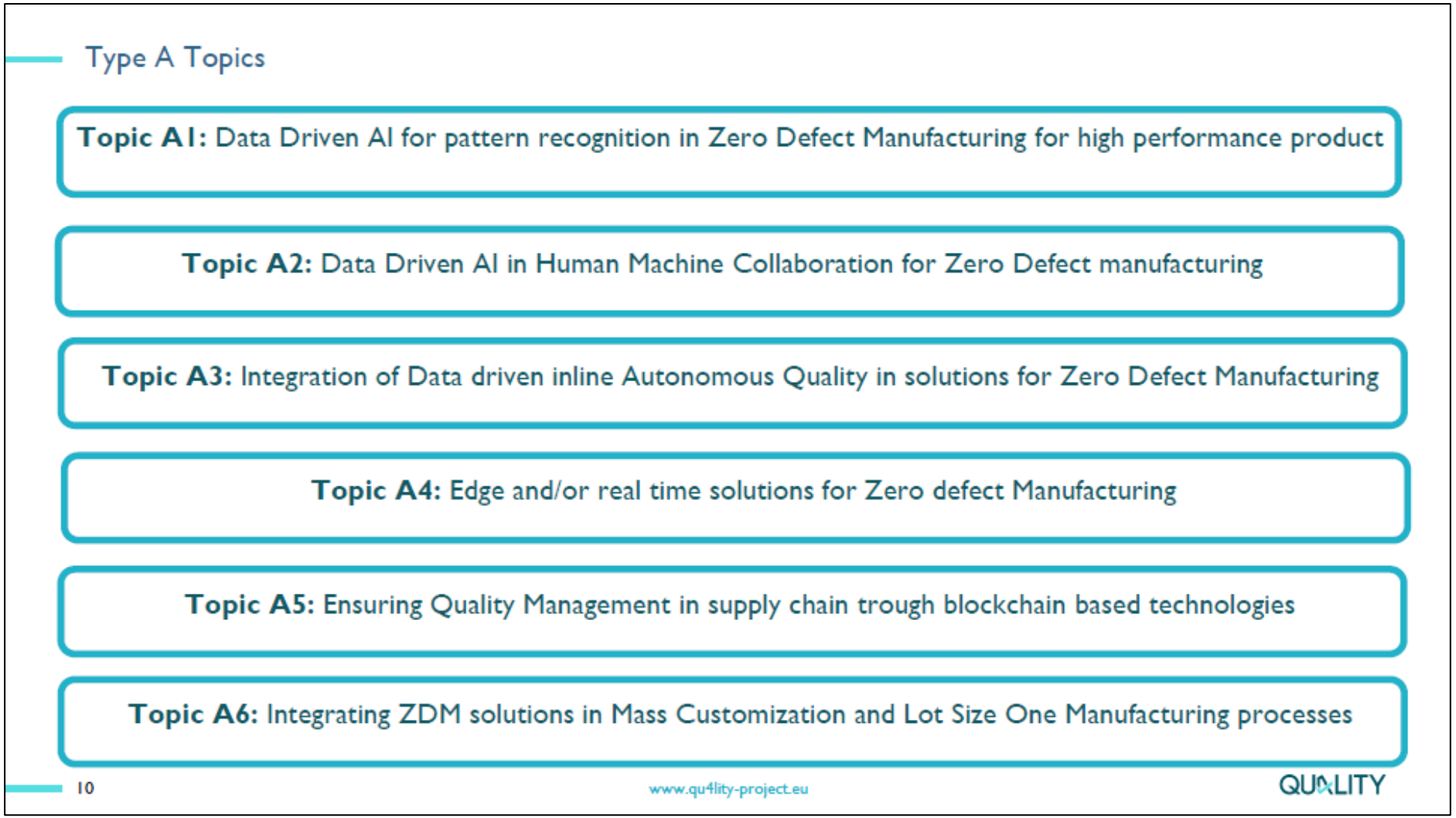
Type A Topics
Topic A1: Data Driven AI for pattern recognition in Zero Defect Manufacturing for high performance product
Topic A2: Data Driven AI in Human Machine Collaboration for Zero Defect manufacturing
Topic A3: Integration of Data driven inline Autonomous Quality in solutions for Zero Defect Manufacturing
Topic A4: Edge and/or real time solutions for Zero defect Manufacturing
Topic A5: Ensuring Quality Management in supply chain trough blockchain based technologies
Topic A6: Integrating ZDM solutions in Mass Customization and Lot Size One Manufacturing processes
10
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Requirements

CONDITIONS:

- Proposal must address one of the topics listed
- Proposed pilots should align to the QU4LITY Reference Architecture
- Proposed pilots should use QU4LITY digital enablers/technologies. Nevertheless, pilots may include technologies of the proposers as soon as they align to the QU4LITY ZDM architecture.
- Pilots and their technologies should be integrated in the project's market platform

ALLOCATED BUDGET:

- €300,000 for the funding of 4 proposals (max budget: 75,000 € per proposal)
- Each proposal must be submitted by a single applicant, consortia are not allowed.

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TYPE B: Expansion of QU4LITY pilot systems

The objective of the TYPE B call is to expand the scope of existing digital platforms and pilots with new functionalities and features and address one or more challenges posed by Qu4lity pilots.

OBJECTIVES:

Proposed solutions should align to one or both of the following two objectives/themes:

Validate the expandability of the QU4LITY digital platforms: Proposers should propose and implement extensions to the QU4LITY technologies, notably to the QU4LITY platforms used in the project's pilots.

Complement existing pilots and platforms with added-value features and functionalities: Proposer should propose extensions to existing pilot systems to address specific challenges posed by the pilot

Solutions should contribute to:

Expanding the QU4LITY ecosystem and broadening the solutions QU4LITY portfolio in the market platform: Proposers should describe their solution and how it will be made available through the QU4LITY market platform and Virtualized Innovation Hub.

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Requirements

CONDITIONS:

Solutions should align to the QU4LITY Reference Architecture.
Solutions must addressing challenges raised by the Qu4lity extend existing QU4LITY Digital Platform or Pilots addressing challenges raised by the pilots

ALLOCATED BUDGET:

- €375,000 for the funding of 5 proposals (max budget: 75,000 € per proposal)
- Each proposal must be submitted by a single applicant, consortia are not allowed.

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Eligible costs

- Personnel Costs
- Equipment Costs
- Travel expenses
- Software licenses
- Subcontracting
- Indirect cost (25% of direct costs)

SMEs will receive as funding max 70% of the costs

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Deliverables

Status of development	Timing	TYPE A Deliverables	TYPE B Deliverables
Pilot Maturity Level 1	M2	• Proof of concept • Alignment with the reference architecture • Alignment with the Qu4lity Autonomous Quality concept • M2 cost statement	• Proof of concept • Alignment with the Qu4lity Autonomous Quality concept • Integration strategy in the reference pilot • M2 cost statement
Pilot Maturity Level 2	M7	• Complete development of the pilot • Demo and dissemination material (video, ppt) • Participation to demo event organized by the consortium	• Complete development and integration in the Q of the pilot • Demo and dissemination material (video, ppt) • Participation to demo event organized by the consortium
Pilot Maturity Level 3	M9	• Business model • Integration in the Quality marketplace • Business Plan • M9 cost statement	• Business model • Integration in the Quality marketplace • Business Plan • M9 report

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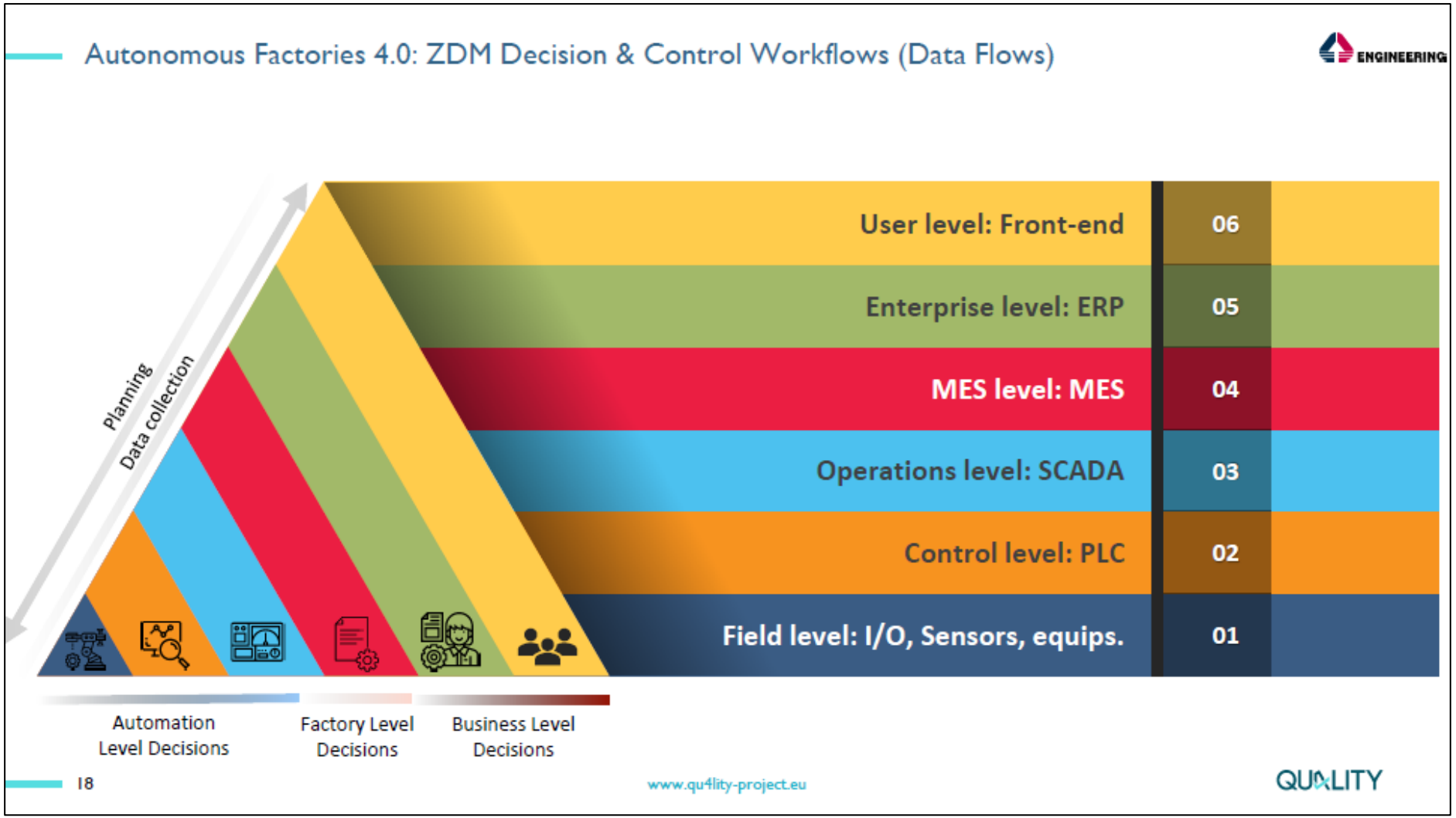
Autonomous Factories 4.0: ZDM Decision & Control Workflows (Data Flows)
ENGINEERING
User level: Front-end
06
Enterprise level: ERP
05
MES level: MES
04
Operations level: SCADA
03
Control level: PLC
02
Field level: I/O, Sensors, equips.
01
Planning
Data collection
Automation Level Decisions
Factory Level Decisions
Business Level Decisions
I8
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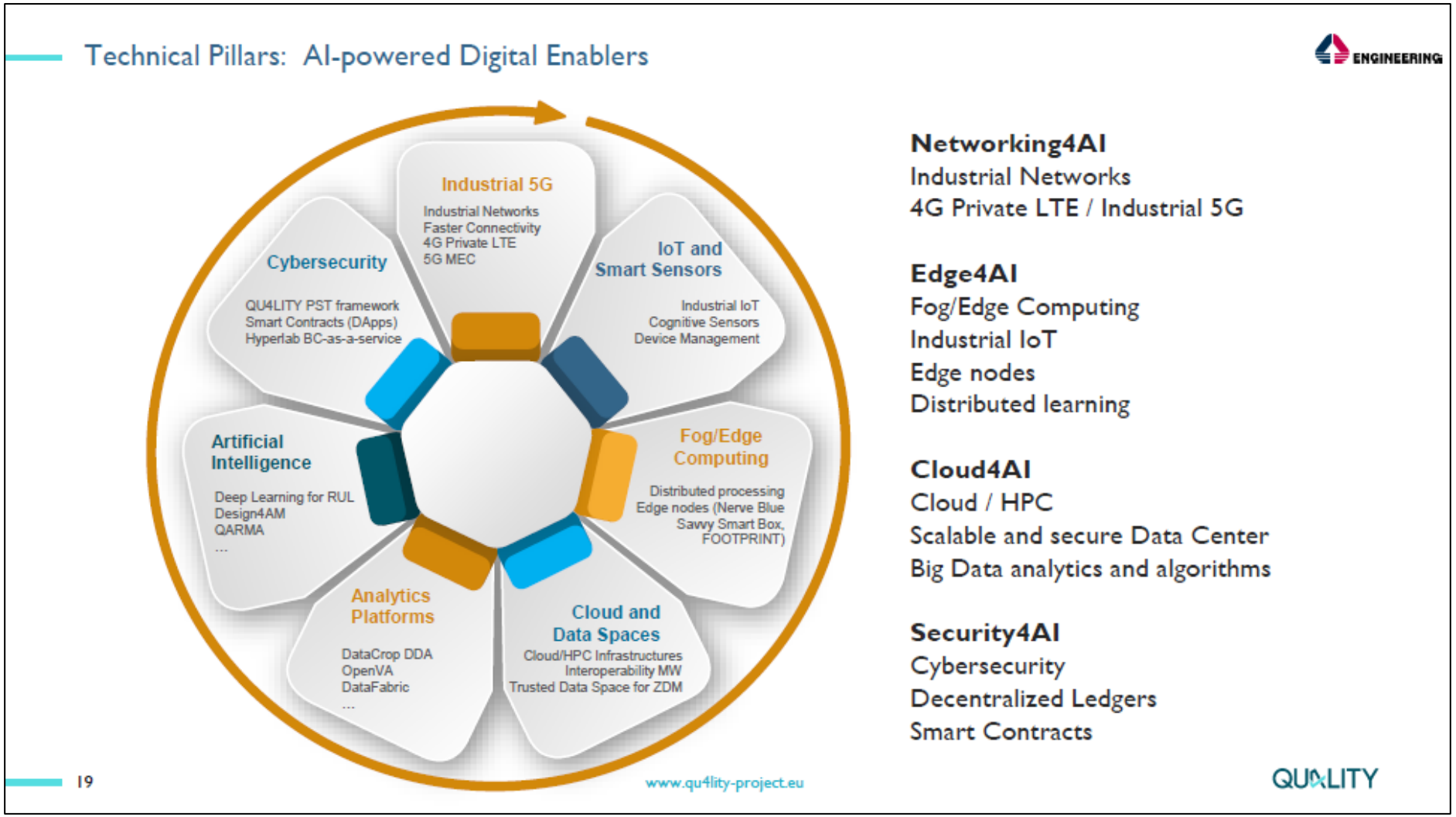

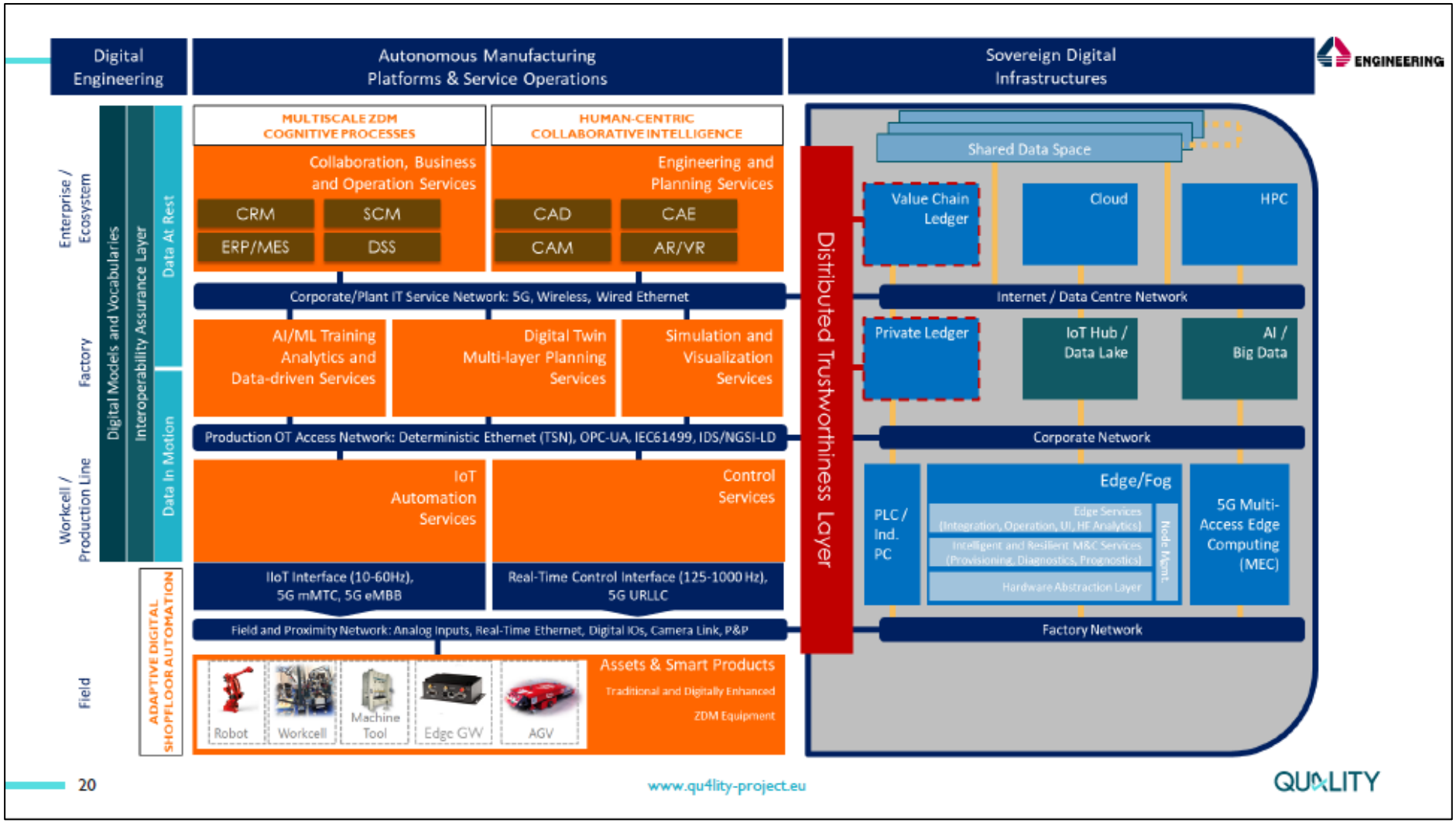
Digital Engineering
Autonomous Manufacturing Platforms & Service Operations
Sovereign Digital Infrastructures
ENGINEERING
Enterprise / Ecosystem
Factory
Workcell / Production Line
Field
Digital Models and Vocabularies
Interoperability Assurance Layer
Data At Rest
Data In Motion
ADAPTIVE DIGITAL SHOPFLOOR AUTOMATION
MULTISCALE ZDM COGNITIVE PROCESSES
HUMAN-CENTRIC COLLABORATIVE INTELLIGENCE
Collaboration, Business and Operation Services
Engineering and Planning Services
CRM
SCM
ERP/MES
DSS
CAD
CAE
CAM
AR/VR
Corporate/Plant IT Service Network: 5G, Wireless, Wired Ethernet
AI/ML Training Analytics and Data-driven Services
Digital Twin Multi-layer Planning Services
Simulation and Visualization Services
Production OT Access Network: Deterministic Ethernet (TSN), OPC-UA, IEC61499, IDS/NGSI-LD
IoT Automation Services
Control Services
IIoT Interface (10-60Hz), 5G mMTC, 5G eMBB
Real-Time Control Interface (125-1000 Hz), 5G URLLC
Field and Proximity Network: Analog Inputs, Real-Time Ethernet, Digital IOs, Camera Link, P&P
Robot
Workcell
Machine Tool
Edge GW
AGV
Assets & Smart Products
Traditional and Digitally Enhanced
ZDM Equipment
Distributed Trustworthiness Layer
Shared Data Space
Value Chain Ledger
Cloud
HPC
Internet / Data Centre Network
Private Ledger
IoT Hub / Data Lake
AI / Big Data
Corporate Network
PLC / Ind. PC
Edge/Fog
Edge Services (Integration, Operation, UI, HE Analytics)
Intelligent and Resilient M&C Services (Provisioning, Diagnostics, Prognostics)
Hardware Abstraction Layer
Node Mgmt.
5G Multi-Access Edge Computing (MEC)
Factory Network
20
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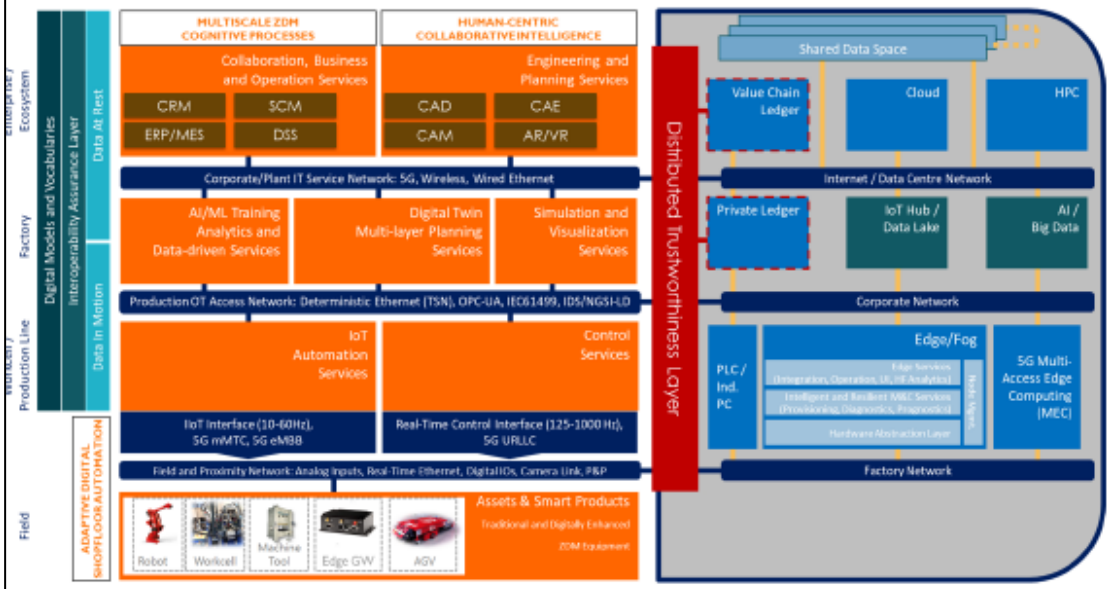
Mapping of OC experiment towards QU4LITY RA

ENGINEERING



- How to perform the mapping:
  - A. Which components of the OC experiment are related to processes/components of the Q-RA?
    (Please also list components that can not be mapped to the RA properly)
  - B. Please describe the OC experiment components with more details.
  - C. What interoperability standards and data exchange formats are used at the interface of these components?

21

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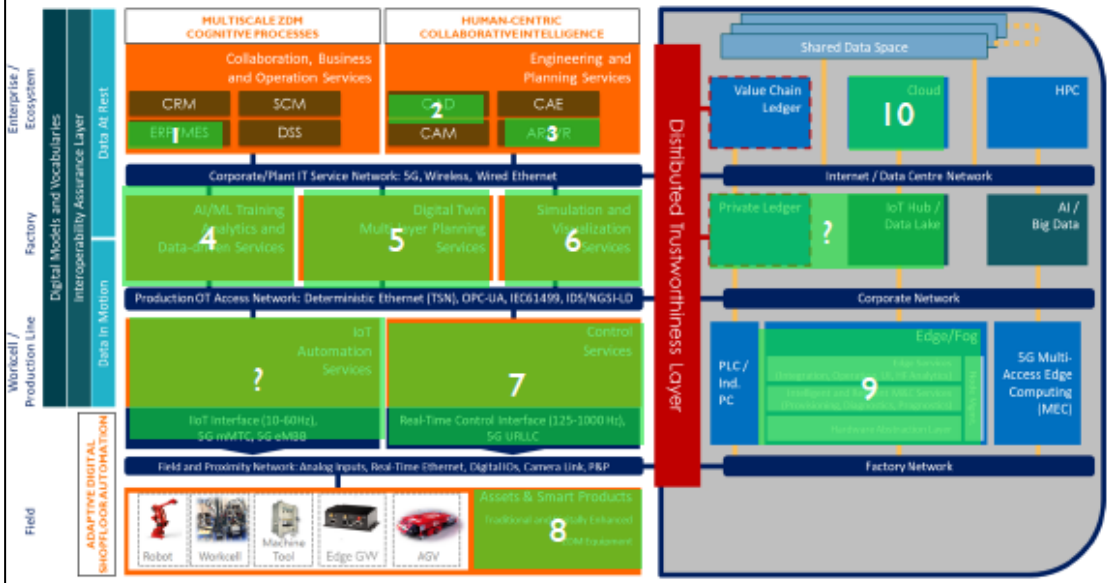
Mapping of OC experiment towards QU4LITY RA (Example)

ENGINEERING



- How to perform the mapping:
  - A. Which components of the OC experiment are related to processes/components of the Q-RA?
    (Please also list components that can not be mapped to the RA properly)
  - B. Please describe the OC experiment components with more details.
  - C. What interoperability standards and data exchange formats are used at the interface of these components?

22

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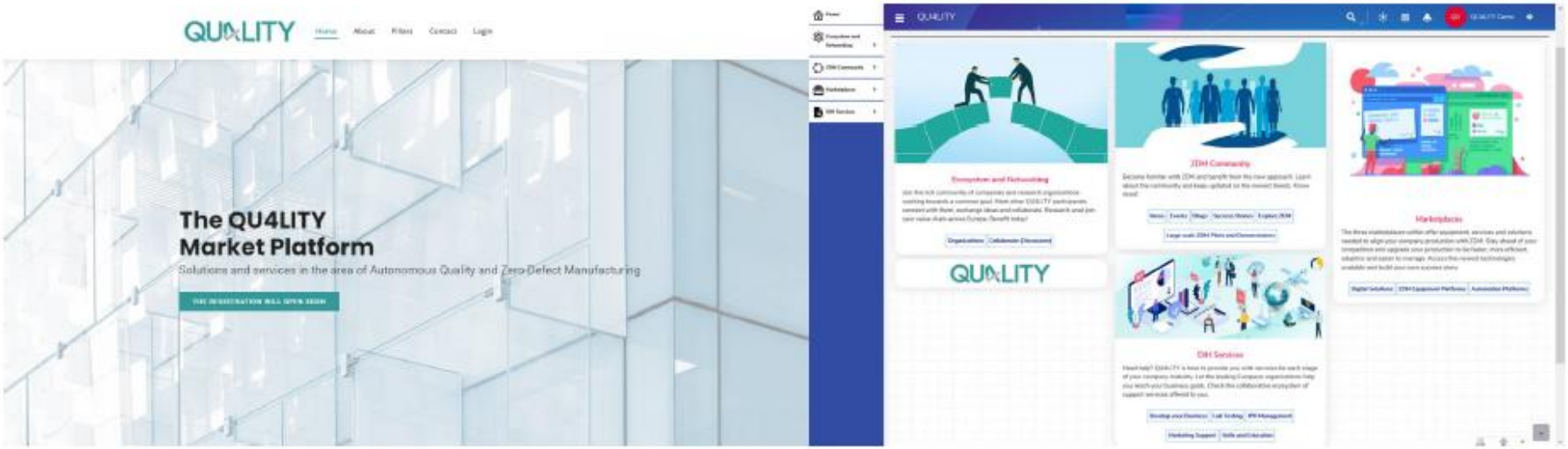
QU4LITY Market Platform Outlook

ENGINEERING



24

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QU4LITY Market Platform Concept & Services

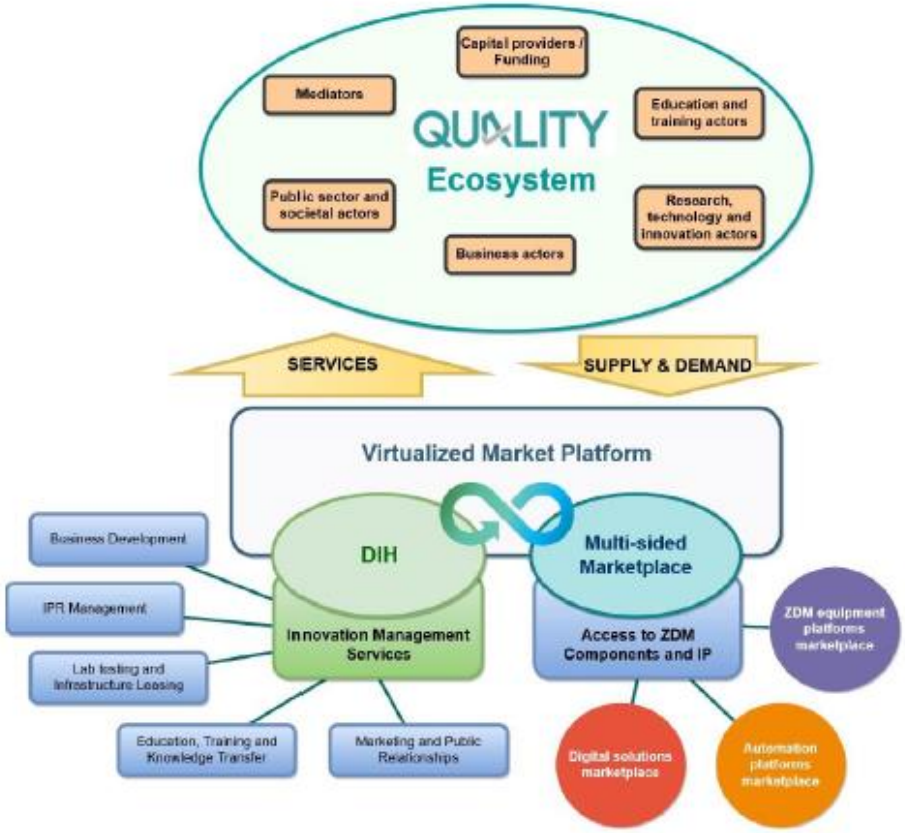
ENGINEERING

Market Platform & QU4LITY Results

- Single Point of Access to QU4LITY Results, notably ZDM related market-ready IP
- Examples:
  - Machine Learning Algorithms
  - BigData Analytics Middleware Platform
  - Enablers for Semantic Interoperability

Market Platform & Innovation Management Services

- Single Point of Access to QU4LITY Innovation Management Services
- Virtualized Digital Innovation Hub Concept
- Examples:
  - Access to Experimental Facilities (Testbed)
  - Training & Education Services
  - Support for Business Case Development



25

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QU4LITY Market Platform: IP Issues and value proposition

ENGINEERING

- **Open Call Winner Maintain the Ownership of their results**
  - QU4LITY partners won't claim IP of foreground developments carried out in the scope of Open Call Experiments
  - They will however retain the background that might be used for developing the experiment
  - Market Platform integration does not imply any obligation for sharing IP with QU4LITY partners

- **Value proposition**
  - The QU4LITY Market Platform is an additional promotional channel for the dissemination and exploitation of the market-ready results of the Open Calls → make use of it!
  - Offer your ZDM solutions and market-ready results to new customers and collaboration partners in the QU4LITY community
  - Broaden your market outreach with the QU4LITY and DFA networks
  - Contribute to enhancing the value of the Market Platform for a bigger community

27

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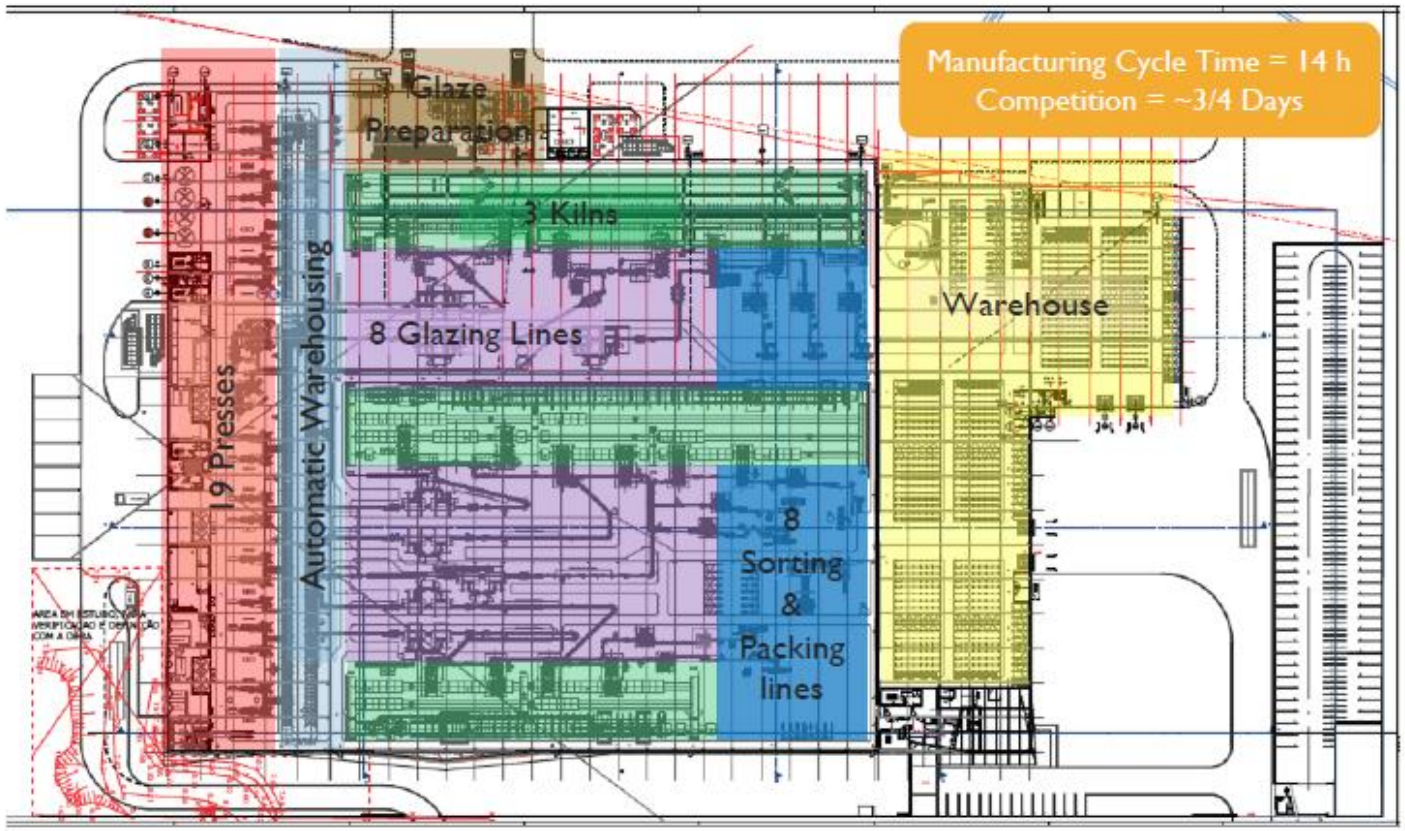
Contents

- Introduction
- Inmvation Projects 2021-2025
- Call type "B" proposal a
- Call type "B" proposal b

RiaStone Factory Shop Floor Diagram – Production Cycle



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Ria Stone - Finished Goods IKEA Families : Färgrik; Flitighet; Dinera

31

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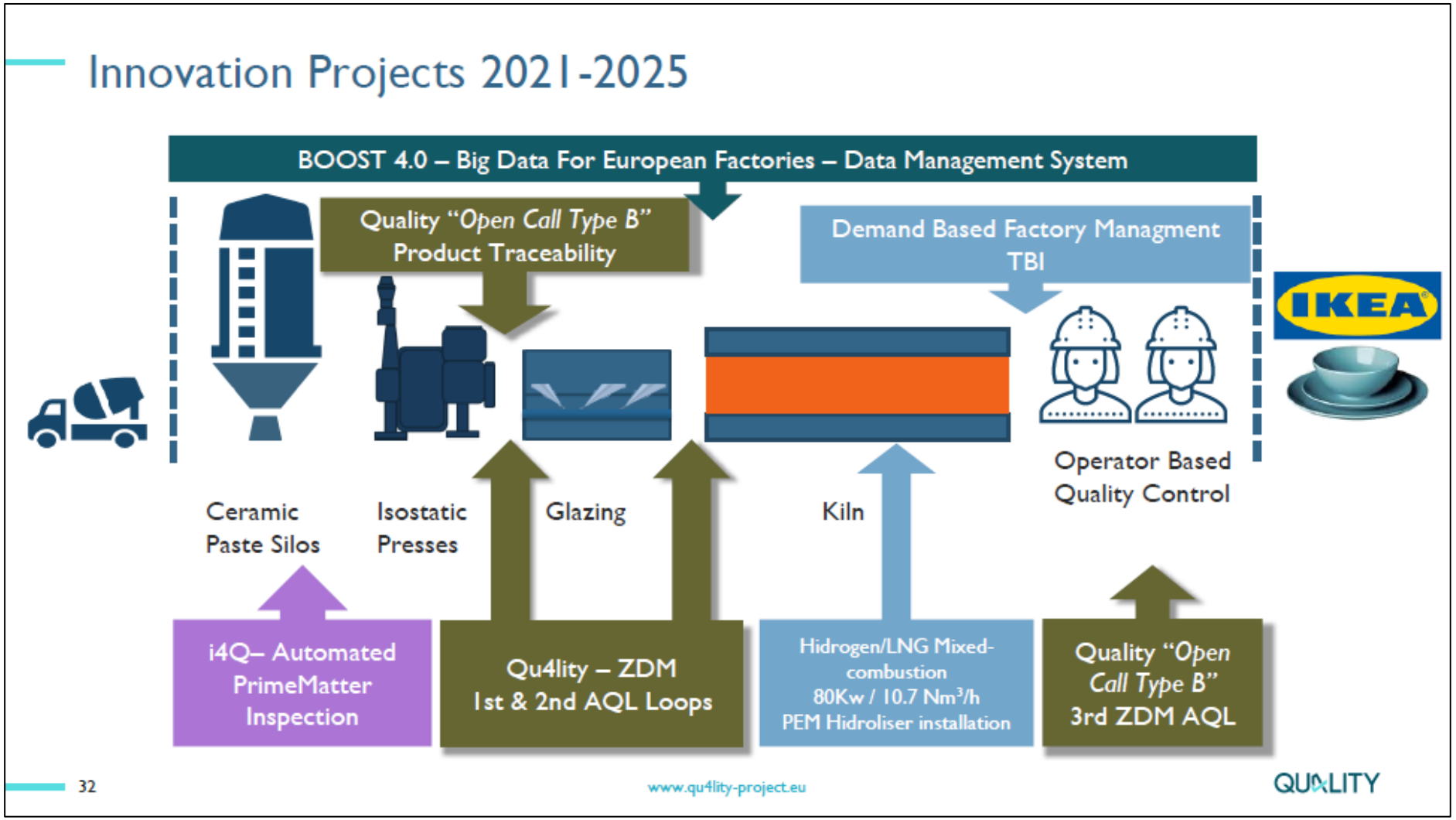
Innovation Projects 2021-2025
BOOST 4.0 – Big Data For European Factories – Data Management System
Quality "Open Call Type B" Product Traceability
Demand Based Factory Managment TBI
IKEA
Operator Based Quality Control
Ceramic Paste Silos
Isostatic Presses
Glazing
Kiln
i4Q– Automated PrimeMatter Inspection
Qu4lity – ZDM 1st & 2nd AQL Loops
Hidrogen/LNG Mixed-combustion 80Kw / 10.7 Nm³/h PEM Hidroliser installation
Quality "Open Call Type B" 3rd ZDM AQL
32
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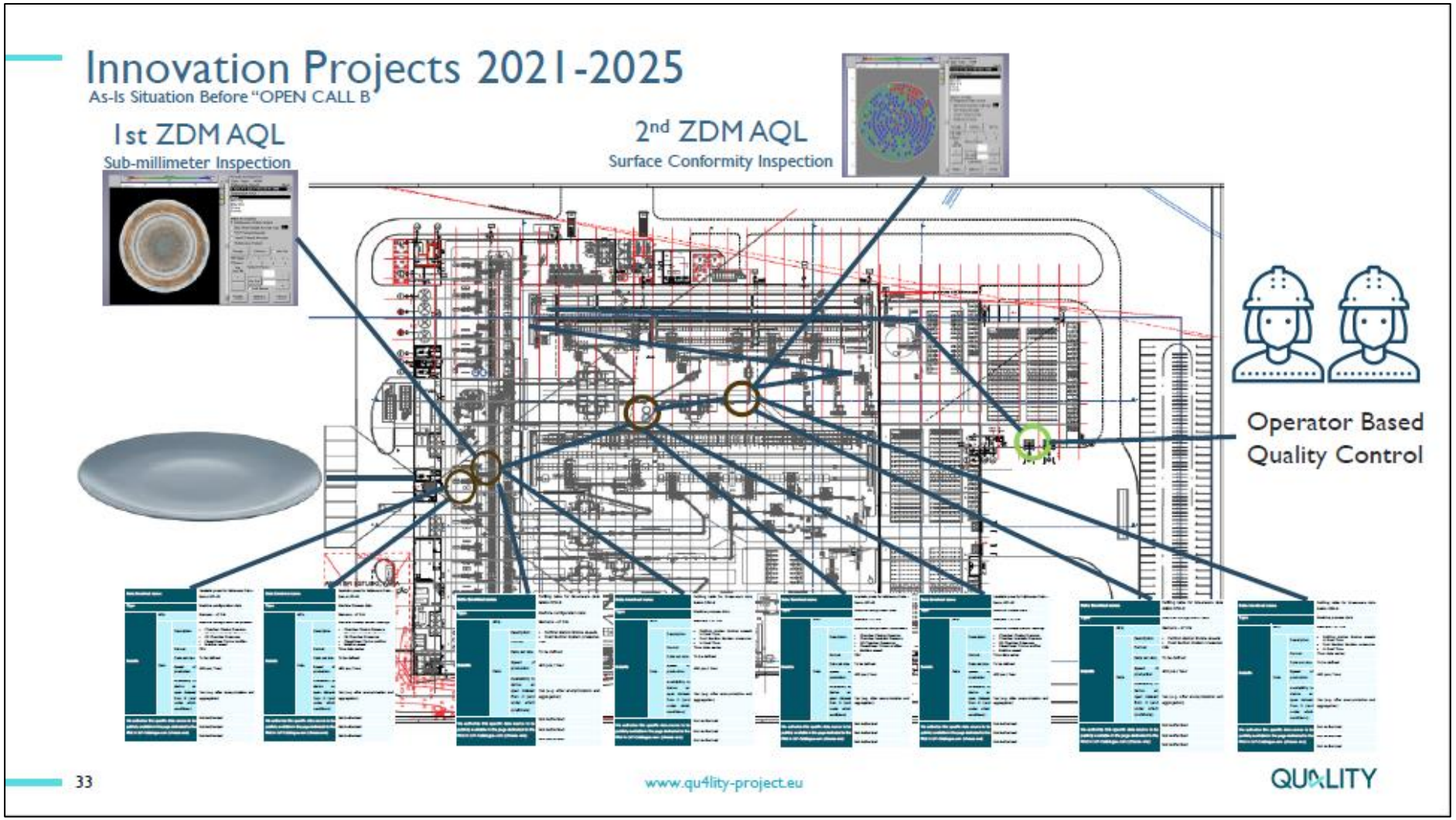
Innovation Projects 2021-2025
As-Is Situation Before "OPEN CALL B
1st ZDM AQL
Sub-millimeter Inspection
2nd ZDM AQL
Surface Conformity Inspection
Operator Based
Quality Control
33
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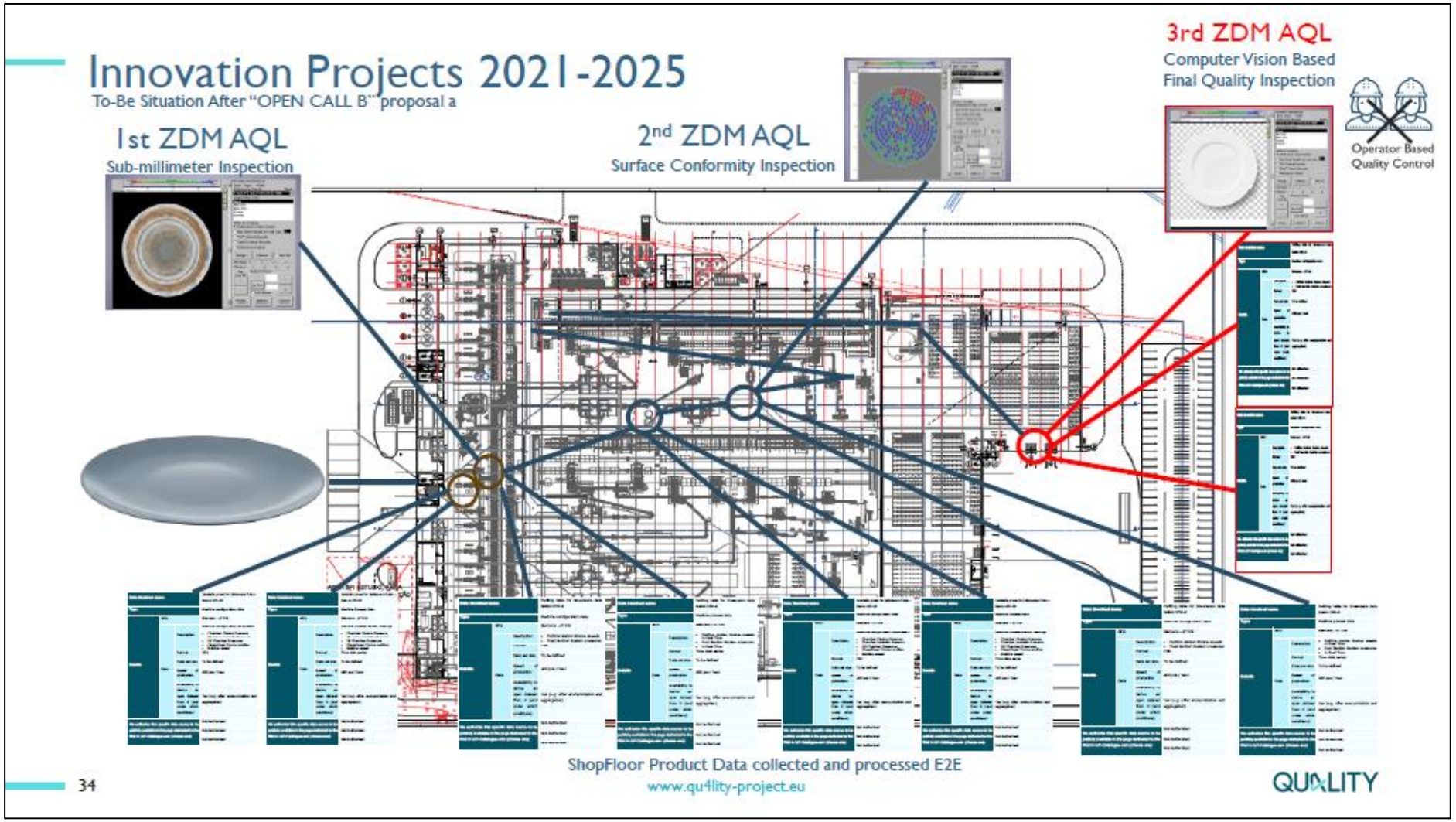
Innovation Projects 2021-2025
To-Be Situation After "OPEN CALL B" proposal a
1st ZDM AQL
Sub-millimeter Inspection
2nd ZDM AQL
Surface Conformity Inspection
3rd ZDM AQL
Computer Vision Based
Final Quality Inspection
Operator Based
Quality Control
ShopFloor Product Data collected and processed E2E
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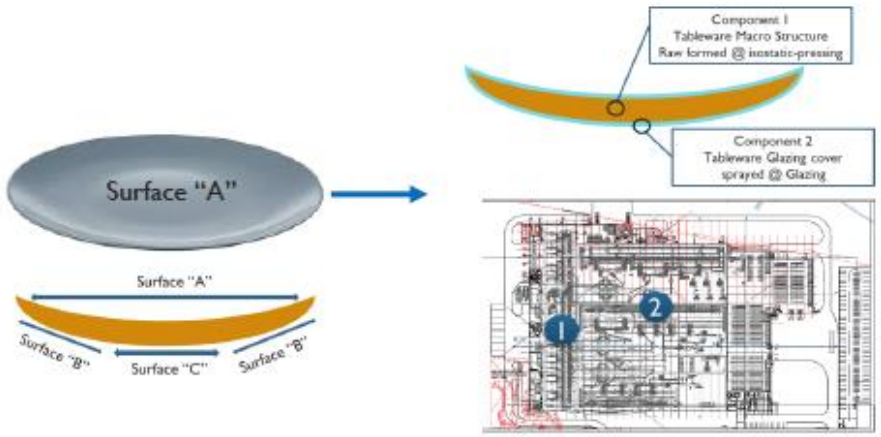
34
QU4LITY

Innovation Projects 2021-2025

"OPEN CALL B" proposal b



Imprint of a TMR readable tag in Plate surface "C" (bottom center) of a 21 digits code per each marked plate

Server Generation of a univocal 21 digits code per each marked plate, syntax:

- *Ikea supplier code*
- *CIP Press Number*
- *Date/Hour/minute/sub-second time*

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35

Functional System Requirements

Univocal Numbering Attribution Capability to support a continuous generation of (minimum) 21 digits per each marked plate

Numbering imprinting Capability to support the writing/imprint of a readable marking in Plate surface "C" (bottom center) of a 21 digits code per each marked plate, which is readable @ a minimum 5cm separation interval from plate to reader device

Numbering printing Capability of positioning, printing and releasing the greenware in a 1 second cycle.

Sightless Marking Capability to be able to effectively print the invisible marking in the plate surface, after the plate is formed in the iso-static presses, and below the applied glazing layer, assuring that at production EOL the plate has to be 100% conformant with the IKEA quality conformity standards

Extreme High Temperature Resilience to be able to survive the eight-hour oven firing cycle @1170 Cº without losing its permanent data readability features, neither becoming visible.

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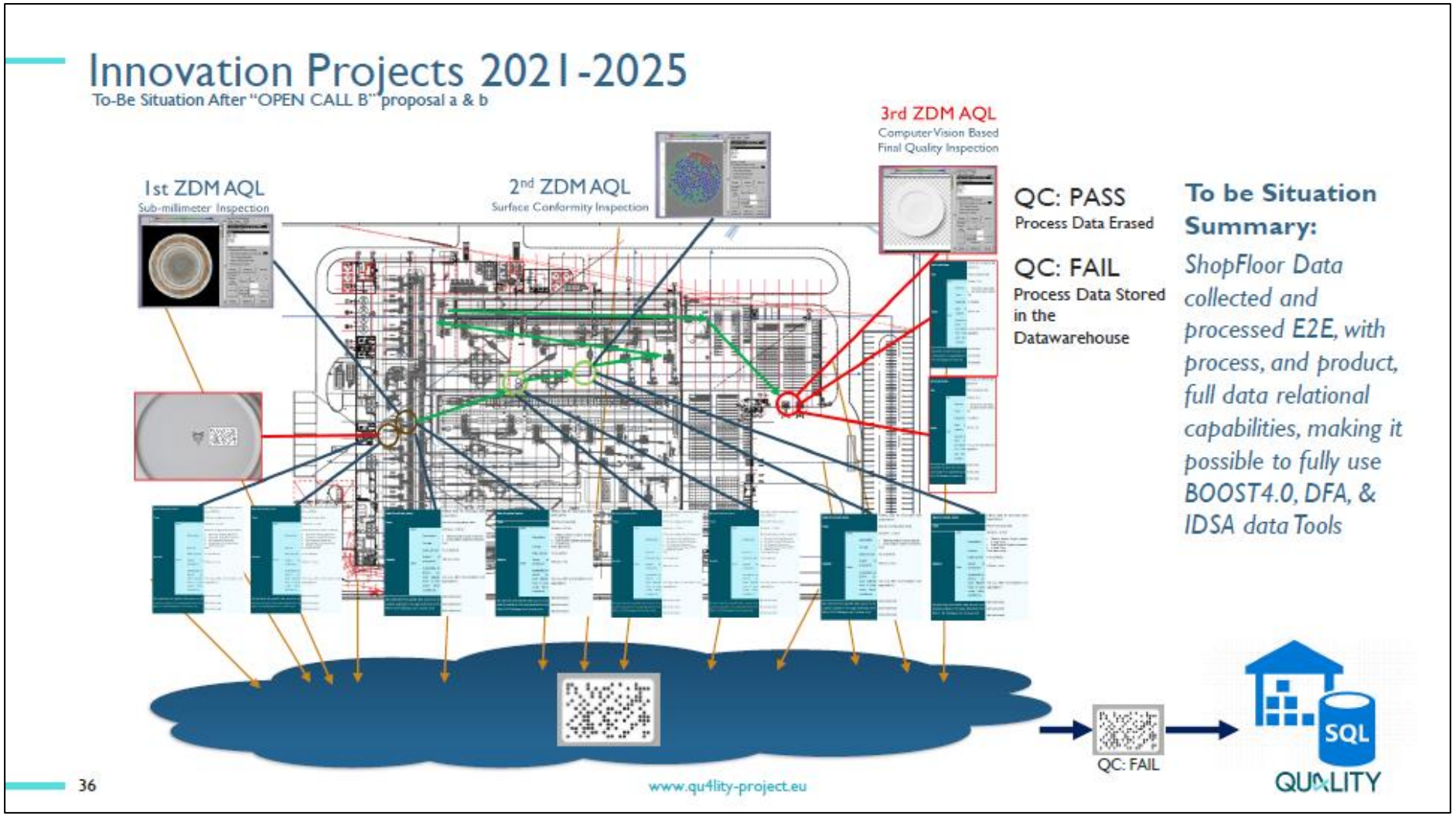
Innovation Projects 2021-2025
To-Be Situation After "OPEN CALL B" proposal a & b
1st ZDM AQL
Sub-millimeter Inspection
2nd ZDM AQL
Surface Conformity Inspection
3rd ZDM AQL
Computer Vision Based
Final Quality Inspection
QC: PASS
Process Data Erased
QC: FAIL
Process Data Stored in the Datawarehouse
To be Situation Summary:
ShopFloor Data collected and processed E2E, with process, and product, full data relational capabilities, making it possible to fully use BOOST4.0, DFA, & IDSA data Tools
QC: FAIL
SQL
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36
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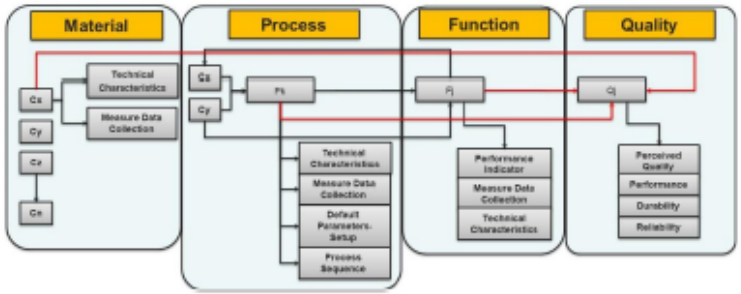
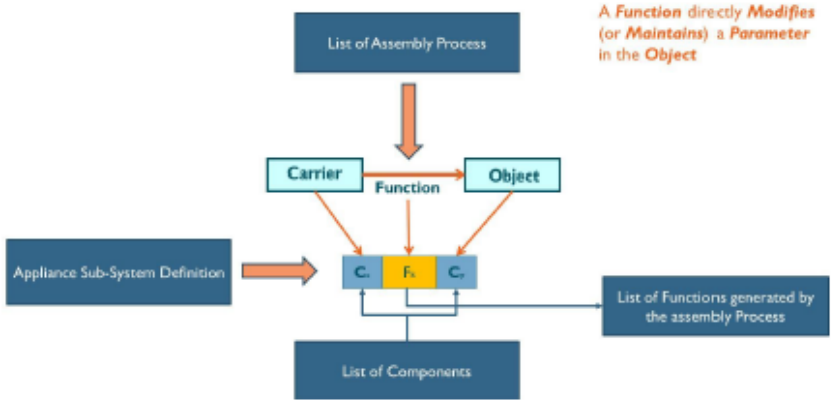
Type B3: Challenge

The MPFQ Model is the integration in term of data and methodology of four different entities

Material – Process – Functions - Quality





BASIC features of graphical tool

- Edit the functional model of a system of components and store the result of the graph in a machine readable format. The graph consist in two type of elements: materials and external entities (represented by rectangles and hexagons) and functions, represented by named arrows.
- Edit the Process Map of a production system using IDEF-0 or other suitable standard representations
- Associate each Function mapped with a specific process step
- Define a set of Quality performances and associate them to a set of components, functions, process

39

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Thank you for your attention !!

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