D2.4 – Usage Viewpoint

WP2 – DESIGN: i4Q Framework Design

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ABSTRACT	The main objective of deliverable D2.4 is to focus on defining how to implement the capabilities and structure of the i4Q Framework by identifying the four key elements of the Usage viewpoint: the tasks, roles, activities and parties in i4Q, considering both human beings, and Software systems. In addition, we consider the relationship among viewpoints, to support the activities and usage of the overall system.

Document History

VERSION	ISSUE DATE	STAGE	DESCRIPTION	CONTRIBUTOR
0.1	01/06/2021	ToC	Table of concepts	ITI
0.2	01/07/2021	Working version	Draft of sections 1-4	ITI, ENG, BIBA, CERTH
0.3	01/08/2021	Working version	Advanced version of section 1-4	ITI, ENG, BIBA, CERTH
0.4	06/09/2021	1st draft	Complete version, ready for internal review.	ITI, ENG, BIBA, CERTH
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1.0	29/09/2021	Final doc	Quality check and issue of final document.	CERTH

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ABBREVIATIONS/ACRONYMS

AAS	Asset Administration Shell
AI	Artificial Intelligence
AF	Architecture Framework
API	Application Programming Interface
AQ	Autonomous Quality
BDA	Big Data Analytics
BDVA	Big Data Value Association
C2NET	Cloud Collaborative Manufacturing Networks
CEP	Complex Event Processing
CPS	Cyber Physical System
CPV	Critical Process Variable
CREMA	Cloud-based Rapid Elastic Manufacturing
DAIRO	Data, AI and Robotics Association
DFA	Digital Factory Alliance
DIN	Deutsches Institut für Normung
DoA	Description of Action
DSA	Digital Shopfloor Alliance
DS-RA	Digital Service Reference Architecture
DSS	Decision Support System
DT	Digital Transformation
ERP	Enterprise Resource Planning
FaaS	Fog as a Service
FOF	Factories of the Future
GDP	Gross domestic product
HPC	High Performance Computing
ICT	Information and communications technology
IDSA	International Data Spaces Association
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IIC	Industrial Internet Consortium

IIRA	Industrial Internet Reference Architecture
IIS	Industrial Internet System
IIoT	Industrial Internet of Things
IMSA	Intelligent Manufacturing System Architecture
IOT	Internet of Things
IPR	Intellectual Property Rights
ISO	International Organization for Standardization
IT	Information technology
I4MS	ICT Innovation for Manufacturing SMEs
MES	Manufacturing Execution System
OPC UA	Open Platform Communications United Architecture
OT	Operational Technology
PAS	Publicly Available Specification
PPP	Public Private Partnership
RA	Reference Architecture
RAF	Reference Architecture Framework
RF	Reference Framework
RAMI4.0	Reference Architectural Model Industry 4.0
RAS	Reliability, Availability, and Serviceability
REST	Representational State Transfer
RIDS	Reliable Industrial Data Services
SDK	Software Development Kit
SOA	Service Oriented Architecture
SRIA	Strategic Research and Innovation Agenda
SSL	Secure Sockets Layer
vf-OS	Virtual Factory Operating System
ZDM	Zero-Defects Manufacturing
ZDMP	Zero Defects Manufacturing Platform

Executive summary

The i4Q Project aims to provide a complete set of solutions consisting of IoT-based Reliable Industrial Data Services (RIDS), the so called 22 i4Q Solutions, able to manage the huge amount of industrial data coming from cheap cost-effective, smart, and small size interconnected factory devices for supporting manufacturing online monitoring and control.

One of the challenges in implementing quality control processes and solutions is the development of the **i4Q Reference Architecture (i4Q RA)** for industrial data services in smart manufacturing, based on innovative technologies and on relevant sector-specific standards.

The design of the i4Q Reference Architecture is an interactive and parallel process, in which the results provided by the analysis across the four key viewpoints of the Industrial Internet Reference Architecture (IIRA) (business, usage, functional and implementation) will serve as input for **i4Q RA.**

This document undertakes the second of these viewpoints, the Usage viewpoint. In it, taking as inputs the work done in the Business Viewpoint (Deliverable 2.3) jointly with the requirements of the pilot use cases defined in Deliverable 1.4. The objective of this deliverable is defining and describing the different activities and tasks associated to the Usage viewpoint and the parties and roles that will execute them.

With this purpose in mind, Section 1 of this document introduces the IIRA, providing the context for the usage viewpoint in addition to present the methodology followed to define the different elements associated to it and presented in the following sections. Section 2, highly related to *"D2.3 – Business Viewpoint"*, enumerates and describes the different parties that can be involved in the execution of activities and tasks and the roles they assume to perform this execution. A list of the tasks that have been identified as most relevant is presented in Section 3. This section presents a list but does not describe the tasks themselves, as the precise goal of a task can change depending on its context, which is provided by the activity that includes it. Therefore, task descriptions are provided within the different tasks identified during the development of the Usage Viewpoint, which are presented in Section 4. The description of activities includes its description, effects or constraints and associated tasks. In addition, these tasks present a description (depending on the context of the activity), the i4Q solutions that can be related to its execution, and roles that would, in principle, undertake this task. It is important to notice that the proposed tasks and activities do not cover all the i4Q solutions proposed. The mapping of i4Q solutions to tasks is presented, as well, in Section 4. Finally, Section 5 presents the conclusions extracted during the execution of this task and the preparation of this deliverable.

Document structure

Section 1 Introduction: Definition of the different Viewpoints and of the methodology followed to identify the core concepts of the usage viewpoint (parties, roles, tasks and activities).

Section 2 Parties and Roles: Definition of the different parties and roles which are considered in the usage viewpoint.

Section 3 Tasks: Presentation of the tasks that have been identified by analyzing the inputs given in the D2.3 Business Viewpoint and the pilots described in D1.3 Demonstration Scenarios and Monitoring KPIs Definition (further detailed in D1.4 Requirements Analysis and Functional Specification).

Section 4 Activities: Presentation of the list of Activities that constitute the main outcome of this deliverable. Each activity includes an ID, Name, Description, Constraints to its execution, the Effects it causes, the Triggers setting it off, and a list of the Tasks that compose it jointly with a workflow representation showing their interrelation

Section 5 Conclusions: Useful outcomes of the deliverable.

1. Introduction

1.1 Context

This deliverable presents the Usage Viewpoint for the i4Q project based on the definitions proposed in the Industrial Internet Reference Architecture (IIRA) [1]. Jointly with deliverables D2.3, D2.5 and D2.6, this deliverable is part of a series of deliverables that describe the different viewpoints proposed in the IIRA. This industrial internet architecture framework provides a standard-based framework – primarily based on the ISO 42010 System Architecture Description - to guide the development of IIoT systems, using a value-driven approach. The basic idea underlying the ISO Architecture Description standard is to analyze and resolve the specific concerns in each of the viewpoints, and as a consequence, creating different architecture models that represent the system architecture from different perspectives.

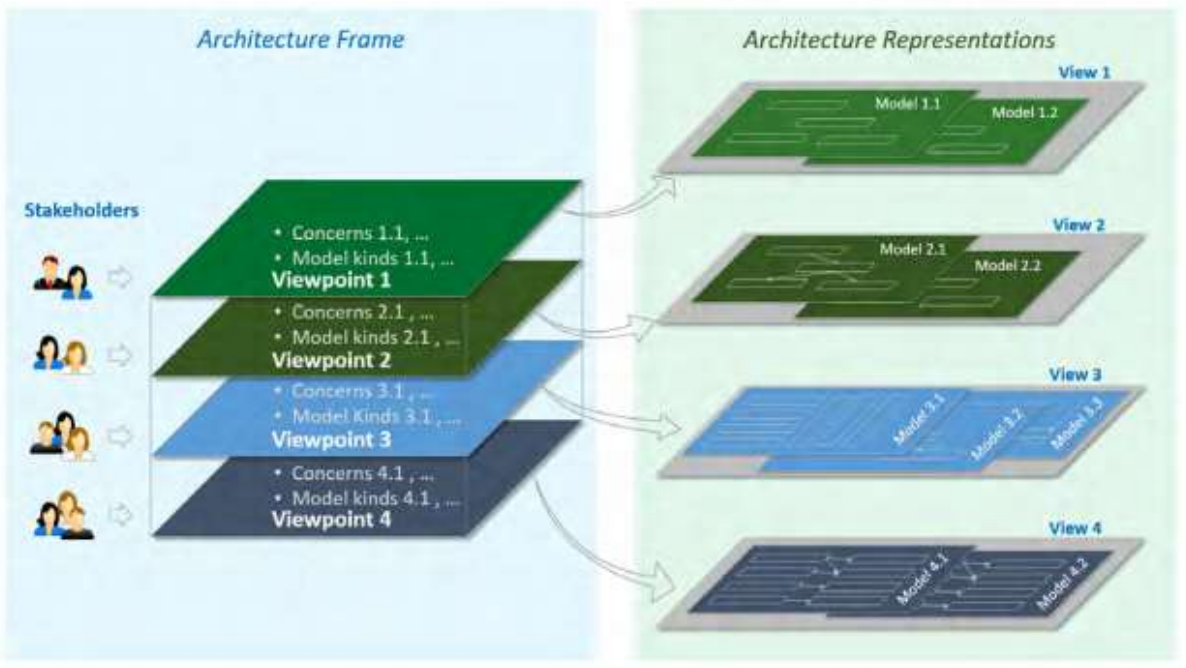

Figure 1. IIRA Reference architecture frame [1]

Figure 1 provides an overview of the IIRA reference architecture. The viewpoints defined in IIRA are:

- **Business viewpoint**: Addresses the specific concerns related to the business stakeholders, their vision and objectives in establishing the IIoT system. The business viewpoint of the i4Q solutions is described in detail in deliverable D2.3
- **Usage viewpoint**: Addresses the specific concerns related to the usage of the IIoT system. The usage viewpoint of i4Q solutions is described in detail in this deliverable.
- **Functional viewpoint**: Addresses the specific concerns related to the functionality of the IIoT system and it is therefore closely related to the functional specification of the system. The functional viewpoint of i4Q solutions is described in deliverable D2.5.
- **Implementation viewpoint**: Addresses the specific concerns related to the implementation of the IIoT system. The implementation viewpoint of i4Q solutions is described in detail in deliverable D.6.

The following subsections provide some more insights about these viewpoints.

1.1.1 Business viewpoint

In the Reference Architecture definition, one of the main objectives is to avoid the risk of a "technology-centric"' approach; for this reason, the viewpoints' definition started with the analysis of a business point of view. The business viewpoint has been defined in task T2.3 (Business Viewpoint) and focused on framing the vision, values, and key objectives.

The definition of the business viewpoint started with the analysis of stakeholders. They have been gathered into two main categories:

- Primary stakeholders, people and organizations who seek, receive, manage and provide IoT based services for quality improvement, having a direct impact on defining main solutions' functionalities.
- Secondary stakeholders, users of information maintained by the primary stakeholders' systems or providers of information needed by the primary stakeholders.

Concerning both categories, different types of stakeholders have been identified: **Decision-Makers** and **Technical Personnel**.

Starting from the stakeholders' classification main elements have been considered: **Vision**, describing a future state of an organization; **Values**, reflecting how the vision may be perceived by the stakeholders involved in the implementation and usage of the i4Q Solutions; **Key objectives**, quantifiable high-level technical and ultimately business outcomes; **Fundamental capabilities**, referring to high-level specifications of the essential ability of the i4Q Solutions to complete specific major business tasks.

Output in terms of objectives and functional capabilities represents the input for the Usage Viewpoint analysis.

1.1.2 Usage viewpoint

The Usage Viewpoint consolidates various aspect of the system's usage, continuing the initial design efforts made in T2.3 where the Business Viewpoint is described. The key objectives and fundamental capabilities identified in the Business Viewpoint will help derive **usage activities and system requirements** of the Usage Viewpoint. The definition of these broad properties of the i4Q Reference Architecture allow for the identification of the Usage Viewpoint's three key elements of usage activities: **tasks, roles and parties**, considering both users and software systems.

The Usage Viewpoint guides the development of the Functional and Implementation Viewpoints. The link between these works is defined within each task's **functional map and implementation map** which links each task with the different functions and implementation components.

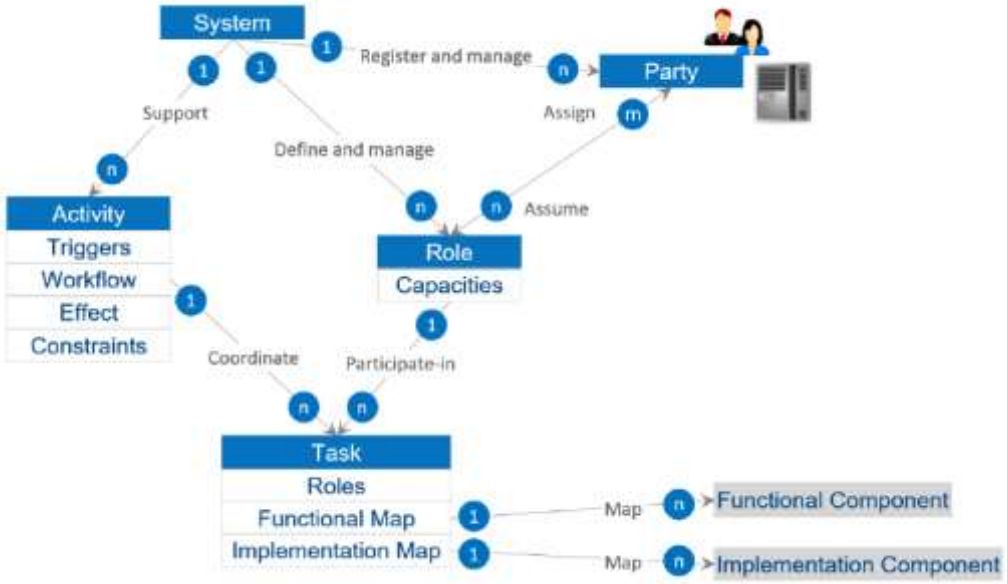

Figure 2. Key concepts on the Usage viewpoint [1]

Tasks are the basic unit of work, such as the invocation of an operation, a transfer of data or an action of a party. A task consists of:

- A *role or roles* responsible for the execution of the task.
- A *functional map* which describes the association with functions or functional components.
- An *implementation map* which describes the dependencies with implementation components.

A **role** is a set of capacities assumed by an entity to participate in the execution of some tasks and are often associated with certain security properties (authorization, privileges and permissions). Roles are assumed by one or more parties.

A **party** is an agent, human or automated, that has autonomy, interest and responsibility in the execution of tasks. A party executes a task by assuming a role that has the right capacities for the execution of the task.

An **activity** represents the coordination of tasks (and possibly other activities) required to realize a well-defined process of the system. An activity consists of:

- A *trigger.* One or more conditions under which the activity is initiated. It may be associated with one or more roles responsible for initiating or enabling the execution.
- A *workflow* describing the organization (sequential, parallel, conditional, iterative) of tasks.
- An *effect* which describes the difference in the state of the system after the activity is successfully completed.
- *Constraints* are system characteristics that must be preserved during execution and after the new state is achieved, such as data integrity, data confidentiality or resilience.

1.1.3 Functional viewpoint

The functional viewpoint focuses on the functional aspects of i4Q Solutions. It considers their internal functional structure, defining its internal functional components, as well as the interfaces and interrelations with other solutions and external systems. These elements are coordinated with the usage viewpoint, linked to the user activities defined therein and with the business viewpoint, describing how the fundamental system capabilities are implemented from a functional viewpoint.

The Industrial Internet Reference Architecture (IIRA) document defines within the functional viewpoint a functional model which consists of different **functional domains** (Control, Operations, Information, Intelligence, Application and Business), together with a set of **system characteristics** (safety, security, reliability, resilience, privacy, scalability, among others) and **cross-cutting functions** (connectivity, distributed data management, Industrial Analytics, Intelligent and resilient control).

1.1.4 Implementation viewpoint

The **Implementation** viewpoint, in deliverable D2.6, will describe the IIoT i4Q Architecture, its technologies, system components and interconnections between them for its implementation.

In order to achieve this, it will have as inputs, from **Business** viewpoint (D2.3) its business-oriented approach that identifies stakeholders and their business vision, values and objectives to map them to system capabilities, from **Usage** viewpoint (D2.4) the activities and tasks identified to implement the capabilities and structure of the i4Q Framework for which will provide implementation maps with their associated components, and finally from **Functional** viewpoint (D2.5) the identified functional components, flows circulating among them and their typical operations.

Implementation viewpoint, based on cloud computing patterns, with technologies such as Edge computing, Microservice applications and Function as a Service (FaaS), will provide a detailed architecture considered instrumental to implement the software described in this viewpoint.

1.2 Methodology

This section describes the methodology followed to identify the core concepts of the usage viewpoint (parties, roles, tasks and activities). The starting point is the business viewpoint, documented in deliverable D2.3, "Report on Business Viewpoint" and deliverable D1.3, "Demonstration Scenarios and Monitoring KPIs Definition".

In D2.3, a number of stakeholders are identified and classified into hierarchical groups. From these, a set of "parties" and a set of "roles" are identified, according to the different granularity of the semantics of such stakeholders. Then, regarding the identification of the tasks, the focus is put on one of the subgroups of interest called "Internal Team". This group includes a number of stakeholders ("Managers and decision makers", "Production team"). For a selection of those stakeholders, some characteristics and properties are identified, including a list of "fundamental capabilities" which are "high-level specifications of the essential ability of the i4Q Solutions to complete specific major business tasks". In D2.3, the fundamental capabilities are expressed in terms of specific actions that each stakeholder must be able to perform.

Then, in D1.3, the pilots of the project are reviewed and for each pilot, several scenarios are identified. First, there are the so-called "As Is" scenarios, which show a number of specific existing operating workflows that are currently in operation in the industrial processes proposed by the partners leading the different use cases. Then, the "To Be" scenarios improve and extend the "As Is" scenarios, by using the functionality offered by the i4Q solutions. The description of these scenarios is used as inputs to refine the insights obtained from the fundamental capabilities mentioned above. The final product is the required list of tasks. Each task includes a description, the role or roles executing it and whether it involves any i4Q solution.

Finally, the tasks are combined into activities (that can be informally seen as workflows). These activities include, as well, a description, the triggers that set the activity off and the effects it causes. The main input to produce them is the information provided in D1.3, whose "To Be" scenarios give the insights on how the sequence of tasks should be executed.

2. Definition of Parties and Roles

In this section we present the different parties and roles that will be considered for the usage viewpoint. This section relates directly to the work made in **D2.3 Business Viewpoint**. [2]

2.1 Parties Description

- i4Q **Technology Provider**: Inside the i4Q consortium, this is the team in charge of offering a solution to the problems exposed, realizing the i4Q RIDS. They consult with manufacturers in order to identify problems or areas that can be improved. Solutions will contribute to enhance manufacturing processes. They are considered primary stakeholders and are mainly divided into:
- **System developers**: Modifies the solution by code changes.
- **System maintainers**: Modifies the customer-related aspects of the solution by changing the configuration, modifying the code if required.
- **System administrators**: Modifies all aspects of the solution by changing the configuration
- **Customers – Manufacturers Internal Team**: They represent the main users of i4Q RIDS and express a strong interest and involvement in the solutions design and implementation phases. In i4Q possible potential customers are mainly represented by companies operating in the manufacturing domain (e.g., pilots involved in the project). Here we can identify:
- **Production Team**: it encompasses most of the functions associated with manufacturing operations and control, manage the production planning:
- **Quality Team**: it is a group of professionals dealing with quality control and assurance in several areas (e.g., for final products, for raw material, etc.). It inspects, measures and tests produced items comparing them with the expected item deciding if the production is working as it should or something should be changed.
- **Inventory Team**: Every asset, machine and produced item must be controlled and properly stored. The functions of product inventory control typically include managing the inventory of finished products; reporting on inventory to production scheduling; arranging physical loading/shipment of goods in coordination with product shipping administration.
- **Maintenance Team**: The main responsibility of this group is to keep machinery and assets functional and up to date. When a faulty production equipment blocks the production team, the maintenance team is in charge of providing a solution so the production can keep up with customer needs.
- **Engineering Team**: This is the technical group in charge of product development, mainly acting in the design phase and in strong connection with Production Team and Maintenance Team.

2.2 Roles Description

The following roles have been identified to model the usage viewpoint.

Production Team:

- *Processing operator*: In charge of directly operating with the production machinery. It controls the status of production requests, configures production parameters, controls the status of resources and process history, intervenes when a problem occurs in the production process and asks for support if needed.

- *Production scheduler*. Manages the overall production process. It is the one in charge of the production plant schedule and decides the best course of action depending on the current situation; in particular: sets up a short-term production plan based on the production schedule; checks the schedule against raw material availability and product storage capacity; checks the schedule against equipment and personnel availability; modifies the production plan periodically to account for equipment outage, manpower and raw materials availability.
- *Assembler*. In charge of assembling a machine or a product. It monitors the status of all subcomponents in order to verify the availability and the quality of the final output.

Quality Team:

- *Quality manager*. In charge of planning quality check procedures, issuing to manufacturing and testing laboratories in accordance with requirements from technology, marketing, and customer services, applying standards and customer requirements for material quality, setting standards for material quality, collecting and maintaining material quality data, certifying that the product was produced according to standard process conditions.
- *Quality inspector*. It performs specialized tests in a laboratory to measure the quality of production samples, both raw material and finished product. These tests can be related to the production process, for internal quality evaluation or to respond to customer complaints. As part of the quality assurance team, it makes sure that manufactured items meet the defined quality standards using specific machines.

Maintenance Team:

- *Maintenance manager*. Develops maintenance cost reports, and coordinates outside contract work effort, providing a preventative maintenance program.
- *Maintenance operator*. It provides maintenance for existing installations. If a problem arises in a machine, it realizes specific maintenance procedures, so the assets are functional and up to date.
- *Maintenance service scheduler*. It is responsible for the state of the machinery and assets involved in the production process and specifies the plan for future work orders. It provides equipment monitoring to anticipate failure, including self-check and diagnostic programs. Together with the production scheduler, plan and prepare assets maintenance so all the assets in the production process are up to date and fully functional as required by the business processes.
- *Customer support operator*. It provides support to customers attending to their needs and demands. It is the person that directly communicates with customers. It also provides status and technical feedback on performance and reliability to process support engineering.

Engineering Team:

- *Product engineer*. It is in charge of products development, defining process and product requirements and also equipment and resource requirements, as related to the production of the products. It follows up on technological developments, issuing requests for modification (e.g., new design drawings, maintenance; minor equipment and process modifications).
- *Process support engineer*. It coordinates engineering functions, also providing technical support to operators and instructions on how to handle equipment. This may include engineering standards for process equipment design techniques and process operational

methods; operating instructions on how to make products; production rules and the standard materials, equipment, and other resources used; material safety data sheets; environmental and safety operating limits and constraints.

- *Data & Analytics engineer*: it is the job of building data products that enable the rest of the team to do their jobs effectively and answer their own questions. They manage core data infrastructure, ensuring data is available and accessible across the organization, and partners with business stakeholders to answer questions with data, build dashboards and reporting, and carry out exploratory analysis. It uses statistics and machine learning to extract value from data (e.g., solving optimization problems, building prediction models and more).

Inventory Team:

- Every asset, machine and produced item must be controlled and properly stored. The functions of product inventory control typically include: managing the inventory of finished products; reporting on inventory to production scheduling; arranging physical loading/shipment of goods in coordination with product shipping administration.

3. List of potential Tasks

This section presents the tasks that have been identified by analyzing the inputs given in the **D2.3 Business Viewpoint** and the pilots described in **D1.3 Demonstration Scenarios and Monitoring KPIs Definition** (further detailed in **D1.4 Requirements Analysis and Functional Specification**). These tasks constitute the building blocks of the activities defined in Section 4.

Note that these tasks are not named following any particular convention or scheme. The naming of the tasks aims to ease the comprehension of the goal of the task, thinking specially about non-technical or specialized readers. Appendix I relates the proposed tasks to the EPCIS (Electronic Product Code Information Services) notation [3] and shows the approach with a small but explicit example how to inject the tasks into the information set of an EPCIS message.

3.1 Task List

Id	Name
T00	Produce (manufacture, build, ensemble, etc.) an item (part, product, etc.)
T01	Sense data during the item production process
T02	Predict the quality of an item in production time
T03	Select samples
T04	Manually check the quality of an item
T06	Compare quality measures of an item against reference quality measures
T08	Admit the item
T09	Reject the item
T10	Correct the item
T11	Decide whether to modify machine parameters
T12	Propose new values for machine parameters
T13	Decide if the problem can be solved with automatic changes
T14	Automatically modify machine parameters
T15	Manually modify machine parameters
T16	Propose the shutdown of the machine or the production process
T17	Compute derived quality evaluation data (e.g., FFT)

Id	Name
T18	Maintain the production equipment (disassemble, calibrate, repair, reassemble, test, etc.)
T19	Publish AI/ML Model
T20	Store Data
T21	Stop production
T22	Train a model with the provided data
T23	Reception of raw matter/goods
T24	Ensure legal obligations from AI
T25	Storage of raw materials/goods
T26	Admission of raw materials/goods
T27	Transportation to storage
T28	Discard lot
T30	Prepare to store
T32	Store
T33	Prepare to deliver
T34	Load into a transportation vehicle
T35	Deliver
T36	Prepare data
T37	Perform analysis
T39	Check raw materials or components in stock
T40	Order new stock
T41	Propose production schedule
T42	Inform production team
T44	Request rescheduling of production
T45	Check if scheduled or unscheduled maintenance is needed

Table 1. List of proposed tasks

4. Definition of Activities

Taking as input the list of Tasks presented in Section 3, this Section presents the list of Activities that constitute the main outcome of this deliverable. Each activity includes an ID, Name, Description, Constraints to its execution, the Effects it causes, the Triggers setting it off, and a list of the Tasks that compose it jointly with a workflow representation showing their interrelation. In addition, each of the tasks previously identified is extended with a Description, the i4Q solutions involved in its execution and the Role(s) performing it. Note that each task is described in the frame of an activity, thus, the same task might have slightly different descriptions in different activities without altering its essence.

4.1 Activities Description

A00 - Production of an item

Activity ID	A00
Name	Production of an item
Description	This activity includes tasks directly related to the production (manufacturing, building, assembling, etc.) of an item and those that have to necessarily be performed during the production of the item
Constraints	Machinery has to be ready (no malfunctioning or under maintenance) to produce items. Sensors, models, stock, have to be ready or be sufficient to not interfere with the production.
Effects	An item is produced
Triggers	"Start production" order
Tasks	T00, T01, T20, T17
Workflows	See Figure 3

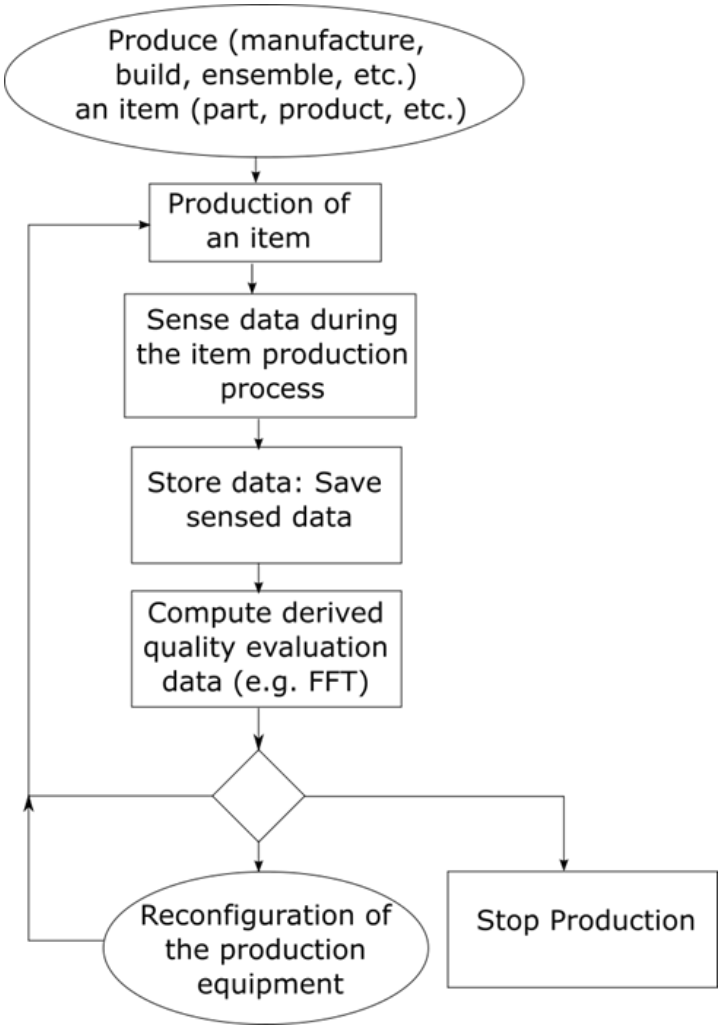

Figure 3. Workflow for Activity A00

Task ID	T00
Name	Produce (manufacture, build, ensemble, etc.) an item (part, product, etc.)
Description	The process of producing an item or any of the parts a product is composed of. This production process can be either manual or automated.
Solutions involved	• 15 - i4Q^{IM}: Infrastructure Monitoring • 17 - i4Q^{PQ}: Data-driven Continuous Process Qualification
Roles	Assembler

Task ID	T01
Name	Sense data during the item production process
Description	The production process is complex and may include several actions performed manually or automatedly. The process may be monitored by different sensors that provide information in (near) real time to assist in the early detection of any problems occurring during the manufacture.

Solutions involved	• 9 - i4Q^{DIT}: Data Integration and Transformation Services • 15 - i4Q^{IM}: Infrastructure Monitoring
Roles	Quality Inspector

Task ID	T20
Name	Store data.
Description	Save the sensed data into a data repository for further use.
Solutions involved	• 8 - i4Q^{DR}: Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines • 3 - i4Q^{BC} Blockchain Traceability of Data
Roles	Quality Inspector

Task ID	T17
Name	Compute derived quality evaluation data (e.g., FFT)
Description	In some cases, measures from quality analysis are the input to perform other calculations.
Solutions involved	• 09 - i4Q^{DIT}: Data integration and manipulation services • 10 - i4Q^{DA}: Services for Data Analytics
Roles	Quality Inspector

A01 - Evaluation of an item

Activity ID	A01
Name	Evaluation of an item
Description	This activity includes tasks related to the evaluation of an item and the assessment of its quality
Constraints	The evaluation of items itself must not affect or interfere in the production process. The exception for this rule is that the evaluation drops a result that recommends the detention of the production, or the modification of any parameter related to the production process.
Effects	An item is evaluated as valid or invalid. Further actions are decided.
Triggers	End of activity A00

Tasks	T02, T03, T04, T06, T20, T13
Workflows	See Figure 4

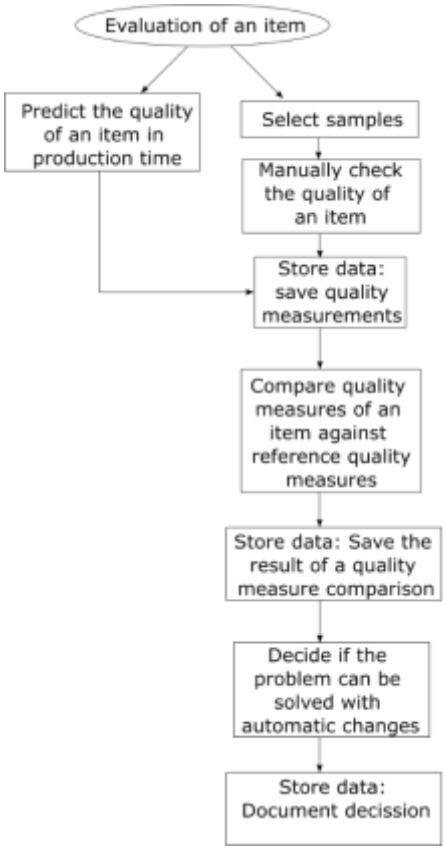

Figure 4. Workflow for Activity A01

Task ID	T02
Name	Predict the quality of an item in production time
Description	Combining the information collected from sensors with AI or machine learning models, it is possible to predict the quality of an item before the manufacturing process is complete. This includes: • Documenting a reference to the models used to produce the prediction • Documenting each prediction • Ensuring that the documentation produced meets the legal obligations
Solutions involved	• 19 - i4Q^{PA}: Prescriptive Analysis Tools • 18 - i4Q^{QD}: Rapid Quality Diagnosis • 8 - i4Q^{DR}:Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines • 3 - i4Q^{BC} Blockchain Traceability of Data

Roles	Quality inspector

Task ID	T03
Name	Select samples
Description	Manual or automated selection of samples for quality analysis or other purposes.
Solutions involved	N/A
Roles	Quality inspector

Task ID	T04
Name	Manually check the quality of an item
Description	Manual evaluation of the quality of an item to find any possible defect or imperfection. Usually performed through visual inspection.
Solutions involved	N/A
Roles	Quality inspector

Task ID	T20
Name	Store data: save quality measurements
Description	Store the results of the quality analysis of an item. We assume these results are stored in a digital format.
Solutions involved	• 8 - i4Q^{DR}:Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines • 3 - i4Q^{BC} Blockchain Traceability of Data
Roles	Quality inspector

Task ID	T06
Name	Compare quality measures of an item against reference quality measures
Description	In order to accept a produced item as valid it must have several measurements within the predefined reference quality ranges. When the quality of an item is inspected, each one of these measurements is checked.
Solutions	N/A

involved	
Roles	Quality inspector

Task ID	T20
Name	Store data: save the result of a quality measure comparison
Description	Store the results of a quality measure comparison after it has been performed. The assumption is that these results are stored in a digital format.
Solutions involved	• 8 - i4Q^{DR}:Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines • 3 - i4Q^{BC} Blockchain Traceability of Data
Roles	Quality inspector

Task ID	T13
Name	Decide if the problem can be solved with automatic changes
Description	• Usually, the problems that arise during the production process are known to operators. Based on user experience and expert knowledge, it is possible to categorize these issues and decide which ones can be solved in an automatic way.
Solutions involved	• 18 - i4Q^{QD}: Rapid Quality Diagnosis
Roles	Processing operator

Task ID	T20
Name	Store data: Document decision
Description	Once the decision of whether the problem can be solved with automatic changes or not, the operator must: • Document how and why the decision is taken (for traceability purposes) • Ensuring that the documentation produced meets the legal obligations
Solutions involved	• 8 - i4Q^{DR}:Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines • 3 - i4Q^{BC} Blockchain Traceability of Data
Roles	Quality inspector

A02 - Reconfiguration of the production equipment

Activity ID	A02
Name	Reconfiguration of the production equipment
Description	This activity includes tasks related to the reconfiguration of the production equipment
Constraints	The resulting configuration of the equipment must be valid.
Effects	The required adjustments and reconfiguration tasks are performed on the production equipment
Triggers	End of activity A01
Tasks	T11, T12, T14, T15
Workflows	See Figure 5

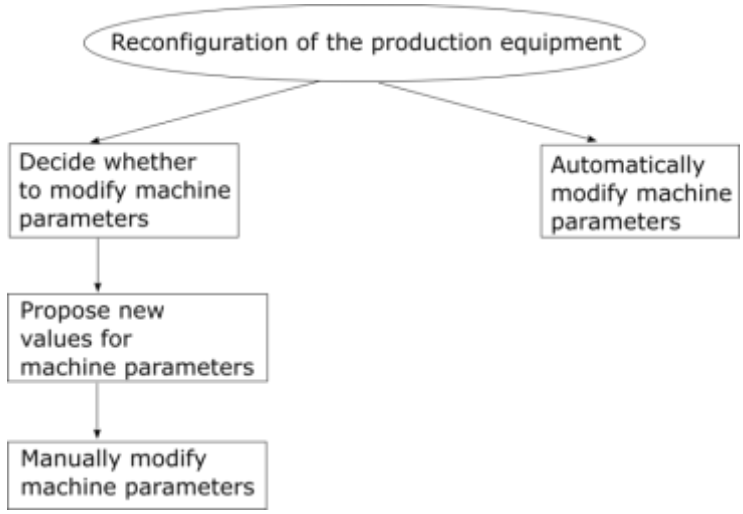

Figure 5. Workflow for Activity A02

Task ID	T11
Name	Decide whether to modify machine parameters
Description	There are different reasons for which the setup of a machine may need to be modified. Reasons for changing this setup can be associated with the data collected from the sensors monitoring the machine, the ratio of admitted and rejected items or the quality analysis of the produced items, for instance. Based on these or other criteria, the actor responsible for the performance of the machine can decide to modify these parameters.
Solutions involved	• 18 - i4Q^{QD}: Rapid Quality Diagnosis • 15 - i4Q^{IM}: Infrastructure Monitoring
Roles	Processing operator

Task ID	T12
Name	Propose new values for machine parameters
Description	If it is considered that modifying the parameters of a machine is required, new values have to be proposed. This proposal may be based on aspects like the data collected from the sensors monitoring the machine, the ratio of admitted and rejected items or the quality analysis of the produced items.
Solutions involved	• 21 - i4Q^{LRT}: Manufacturing Line Reconfiguration Toolkit • 20 - i4Q^{LRG}: Manufacturing Line Reconfiguration Guidelines
Roles	Processing operator

Task ID	T14
Name	Automatically modify machine parameters
Description	A production problem can be assumed to be rectifiable in an automatic way. In this case the associated machine or an external automated agent can measure and evaluate some metrics through a series of sensors and using control techniques actuate on the inputs of the machine to correct the production process.
Solutions involved	• 21 - i4Q^{LRT}: Manufacturing Line Reconfiguration Toolkit
Roles	Processing operator

Task ID	T15
Name	Manually modify machine parameters
Description	When a process cannot be rectified in an automatic way, a human actor has to intervene to manually modify the machine parameters.
Solutions involved	N/A
Roles	Processing operator

A03 - Finalization

Activity ID	A03
Name	Finalization
Description	This activity finalization steps to conclude the production of an item and other

	related steps
Constraints	This activity can only be conducted with items that are finalized.
Effects	The production of an item is concluded. The equipment status is modified, if needed.
Triggers	End of activities A01 and A02
Tasks	T08, T09, T28, T10, T20, T16, T21
Workflows	See Figure 6

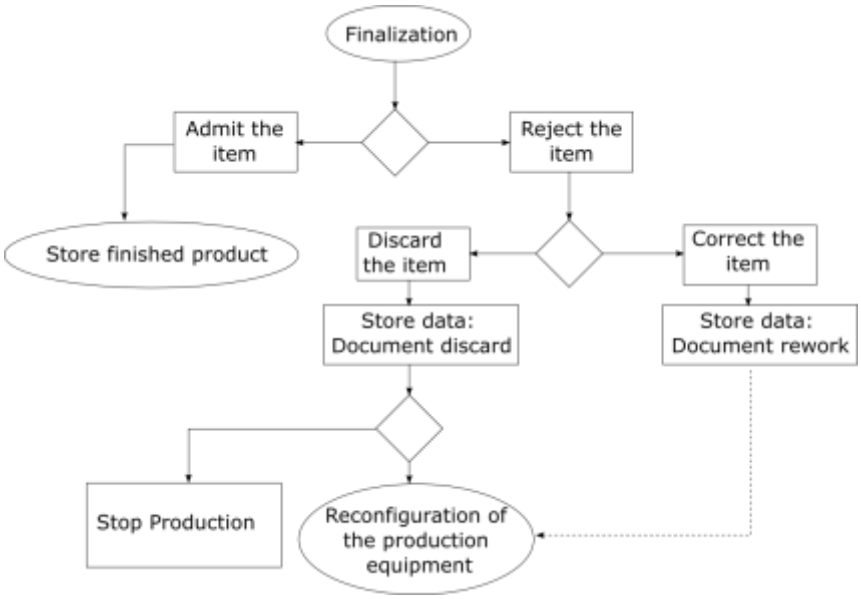

Figure 6. Workflow for Activity A03

Task ID	T08
Name	Admit the item
Description	When an item is inspected, if all the key measurements are within the acceptable ranges specified in the reference quality measures, or a sufficient number of the inspected measures are within these ranges, the item can be admitted as valid.
Solutions involved	• 12 - i4Q^{AD} Analytics Dashboard • 2 - i4Q^{QE} QualiExplore for Data Quality Factor Knowledge
Roles	Quality Inspector

Task ID	T09
Name	Reject the item
Description	When an item is inspected, if not every key measurement is within the

	acceptable ranges specified in the reference quality measures, or the number of inspected measures within the specified ranges is not sufficient, the item is rejected.
Solutions involved	• 12 - i4Q^{AD} Analytics Dashboard • 2 - i4Q^{QE} QualiExplore for Data Quality Factor Knowledge
Roles	Quality Inspector

Task ID	T28
Name	Discard lot (item)
Description	If an item cannot be recovered through reworking it has to be discarded. This implies destroying, discarding it or others.
Solutions involved	• 12 - i4Q^{AD} Analytics Dashboard • 2 - i4Q^{QE} QualiExplore for Data Quality Factor Knowledge
Roles	Assembler, Quality Inspector

Task ID	T20
Name	Store data: document discard.
Description	The actor responsible for the decision of discarding the item has to document why it is to be discarded and store the data supporting its decision in the appropriate repository.
Solutions involved	• 8 - i4Q^{DR}: Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines • 3 - i4Q^{BC} Blockchain Traceability of Data
Roles	Quality Inspector

Task ID	T10
Name	Correct the item
Description	Depending on the reasons not admitting an item it may be considered for correction instead of rejection. This will depend on the kind of measurements that are not within the valid reference quality ranges and whether this measurement can be corrected by undertaking additional actions. This task will trigger the “Production of an item” activity.
Solutions involved	• 10 - i4Q^{DA}: Services for Data Analytics
Roles	Quality Inspector, Assembler

Task ID	T20
Name	Store data: document rework.
Description	The actor responsible for the decision of reworking the item has to document why it is to be reworked and store the data supporting its decision in the appropriate repository.
Solutions involved	• 8 - i4Q^{DR}: Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines • 3 - i4Q^{BC} Blockchain Traceability of Data
Roles	Quality Inspector, Assembler

Task ID	T16
Name	Propose the shutdown of the machine or the production process
Description	A machine or the entire production process may need to be stopped for several reasons. Some examples can be to adapt the production speed to meet the planned production goals or due to problems detected in the quality analysis of the items.
Solutions involved	• 18 - i4Q^{QD}: Rapid Quality Diagnosis • 15 - i4Q^{IM}: Infrastructure Monitoring • 17 - i4Q^{PQ}: Data-driven Continuous Process Qualification • 20 - i4Q^{LRG}: Manufacturing Line Reconfiguration Guidelines • 21 - i4Q^{LRT}: Manufacturing Line Reconfiguration Toolkit
Roles	Assembler Maintenance operator

Task ID	T21
Name	Stop Production
Description	Due to lack of quality, malfunctioning or similar reasons affecting the production, it might have to be stopped.
Solutions involved	• 18 - i4Q^{QD}: Rapid Quality Diagnosis • 22 - i4Q^{LCP}: Manufacturing Line Data Certification Procedure
Roles	Quality Inspector, Quality Manager

A04 – Maintenance management

Activity ID	A04
Name	Maintenance management
Description	This activity includes tasks related to the maintenance of the production equipment
Constraints	Must follow the guidelines given by the production scheduling activity (A10).
Effects	Maintenance actions are applied to the production equipment
Triggers	On scheduled preventive maintenance or unexpected necessary maintenance
Tasks	T45, T21, T44, T18, T20, A02
Workflows	See Figure 7

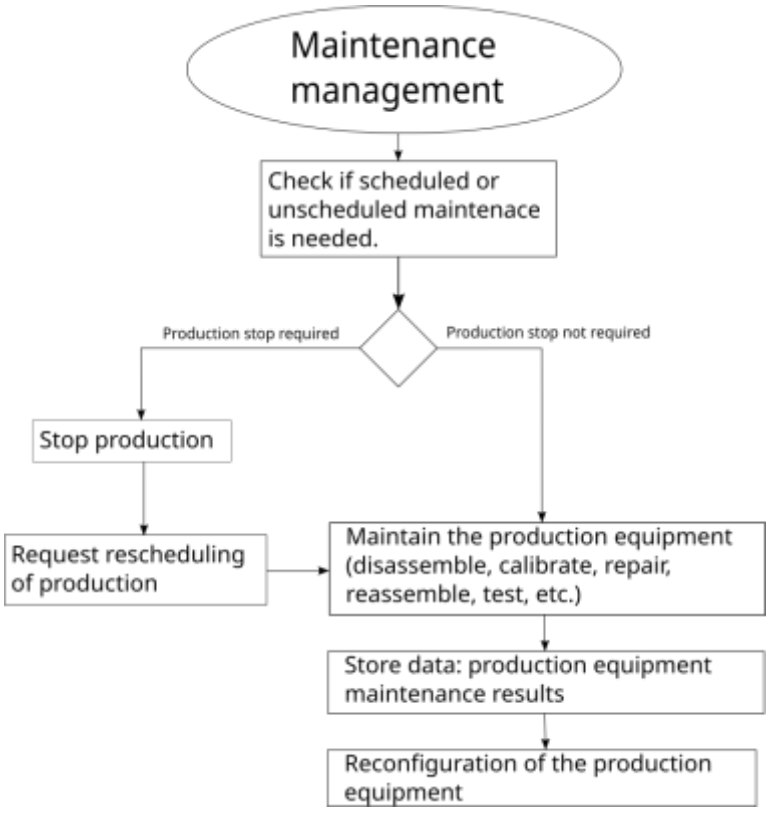

Figure 7. Workflow for Activity A04.

Task ID	T45
Name	Check if scheduled or unscheduled maintenance is needed
Description	The machinery involved in production may need either scheduled maintenance, that can be accounted for in advance or unscheduled maintenance due to unexpected errors.

Solutions involved	• 15 - i4QIM: Infrastructure Monitoring • 17 - i4QPQ: Continuous Process Qualification
Roles	Maintenance service scheduler, Processing operator

Task ID	T21
Name	Stop production
Description	In order to do the required maintenance, production must be stopped if unscheduled (emergency) maintenance coincides with active production.
Solutions involved	• 18 - i4Q^{QD}: Rapid Quality Diagnosis • 22 - i4Q^{LCP}: Manufacturing Line Data Certification Procedure • 15 - i4Q^{IM}: Infrastructure Monitoring
Roles	Maintenance team

Task ID	T44
Name	Request rescheduling of production
Description	If an unexpected production line stop happens, a production reschedule is necessary.
Solutions involved	N/A
Roles	Maintenance service scheduler, production scheduler

Task ID	T18
Name	Maintain the production equipment (disassemble, calibrate, repair, reassemble, test, etc.)
Description	There are several tasks that can lead to production equipment downtime. Examples of these tasks can be due to maintenance, performance tests, calibration, or repairs, among others.
Solutions involved	• 22 - i4Q^{LCP}: Manufacturing Line Data Certification Procedure
Roles	Maintenance operator

Task ID	T20

Name	Store data: production equipment maintenance data
Description	Store the results of an equipment maintenance after it has been performed. The assumption is that these results are stored in a digital format.
Solutions involved	• 8 - i4Q^{DR}:Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines • 3 - i4Q^{BC} Blockchain Traceability of Data
Roles	Processing operator

Task ID	A02
Name	Reconfiguration of the production equipment
Description	This task triggers activity A02.
Solutions involved	N/A
Roles	Processing operator

A05 – Model creation and training

Activity ID	A05
Name	Model creation and training
Description	After a new reference is included, it is necessary to create and train a model that will be used for item evaluation necessary to achieve further goals such as predictive maintenance or automatic reconfiguration. This activity includes the model creation and training necessary for future AI inspection, analysis and evaluation of produced items.
Constraints	A00, A01 and A02 must be available and ready to use in this activity.
Effects	Compute a trained model for item evaluation that allows predictive maintenance, automatic reconfiguration, …
Triggers	New item reference
Tasks	T36-T37-T22-T20-T24-T19
Workflows	See Figure 8

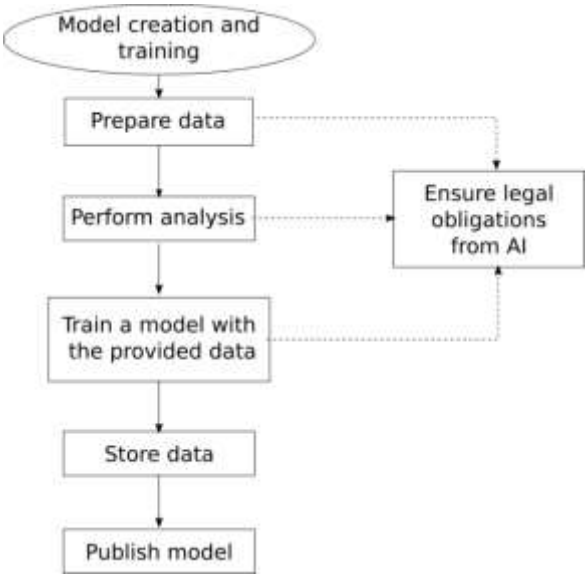

Figure 8. Workflow for Activity A05

Task ID	T36
Name	Prepare data: Model creation and training
Description	In order to train an AI model, it is necessary to gather, clean and filter data from the production process.
Solutions involved	• 09 - i4Q^{DIT}: Data integration and manipulation services • 01 - i4Q^{DQG}: Data Quality Guidelines
Roles	Quality inspector, Data & Analytics engineer

Task ID	T37
Name	Perform analysis: Model creation and training
Description	Gathered data from production must be analysed in order to obtain quality results that are necessary in the model training to obtain an AI model capable of predicting reliable information.
Solutions involved	N/A
Roles	Quality inspector, Data & Analytics engineer

Task ID	T22
Name	Train a model with the provided data
Description	Use the bulk data to train a model capable of relating production parameters with evaluation quality.

Solutions involved	• 11 - i4Q^{BDA}: Big Data Analysis Suite • 16 - i4Q^{DT}: Digital Twin Simulation Services
Roles	Data & Analytics engineer

Task ID	T20
Name	Store data: store the trained model
Description	Store the trained model so it can be used in A03 when necessary.
Solutions involved	• 8 - i4Q^{DR}:Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines • 3 - i4Q^{BC} Blockchain Traceability of Data
Roles	Data & Analytics engineer

Task ID	T24
Name	Ensure legal obligations from AI.
Description	Make sure all the design and procedures followed during model training follows legal obligations, so the resulting AI does not present biases or any other related problems.
Solutions involved	N/A
Roles	Data & Analytics engineer

Task ID	T19
Name	Publish AI/ML model.
Description	Once the model is trained, validated and stored it must be distributed and deployed in every machine so it can be used.
Solutions involved	• 13 - i4Q^{AI}: AI Models Distribution to the Edge • 14 – i4Q^{EW}: Edge Workloads Placement and Deployment
Roles	Data & Analytics engineer

A06 – Reception of an item

Activity ID	A06

Name	Reception of an item
Description	Actions performed upon the reception of an item/raw matter/other from a supplier. The received items can be driven to storage or be evaluated.
Constraints	An item or set of items is received at a particular stage of the production process.
Effects	After being received, an item is stored for its future use or discarded.
Triggers	Reception of new products/items
Tasks	T23, T03, T25, T26, T08, T27, T09, T20, T28
Workflows	See Figure 9

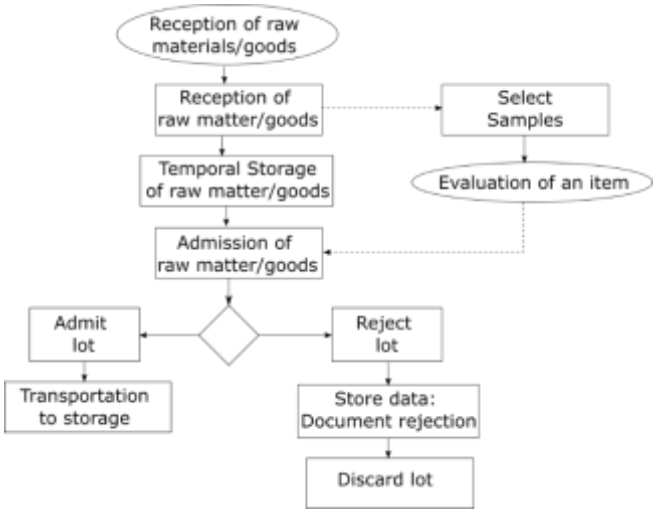

Figure 9. Workflow for Activity A06

Task ID	T23
Name	Reception of raw matter/goods
Description	A lot of raw matter/goods is received in a factory (or equivalent) and unloaded from its transportation.
Solutions involved	N/A
Roles	Inventory Team

Task ID	T03
Name	Select Samples
Description	Items may be sampled with quality analysis purposes (or other). This task

	triggers the “Evaluation of an item” activity. The feedback will be used as an input for the “Admission of raw matter/goods” task.
Solutions involved	N/A
Roles	Assembler, Quality Inspector

Task ID	T25
Name	Temporal storage of raw matter/goods
Description	Received raw matter or goods are stored in the reception bay or in a temporal storage while waiting for being admitted or rejected.
Solutions involved	N/A
Roles	Inventory Team

Task ID	T26
Name	Admission of raw matter/goods
Description	The decision of whether to admit the received raw matter or goods is taken by a person in charge or automatedly, based on a quality evaluation, visual inspection, or others. This task may consume solutions that facilitate the interpretation of results of quality data.
Solutions involved	• 12 - i4Q^{AD} Analytics Dashboard • 2 - i4Q^{QE} QualiExplore for Data Quality Factor Knowledge
Roles	Quality Inspector

Task ID	T08
Name	Admit the item (lot)
Description	The lot of raw matter or goods is accepted if after inspecting and evaluating its samples all the key measurements are within the acceptable ranges specified in the reference quality measures, or a sufficient number of the inspected measures are within these ranges.
Solutions involved	N/A
Roles	Quality operator

Task ID	T27
Name	Transportation to storage
Description	Once an item has been admitted it is transported to storage, where it will remain until needed in production or for its expected use.
Solutions involved	N/A
Roles	Inventory Team

Task ID	T09
Name	Reject the item (lot)
Description	The lot of raw matter or goods is rejected if after inspecting and evaluating its samples not every key measurement is within the acceptable ranges specified in the reference quality measures, or the number of inspected measures within the specified ranges is not sufficient.
Solutions involved	N/A
Roles	Quality Inspector

Task ID	T20
Name	Store data: document rejection.
Description	The actor responsible for the decision of discarding the lot has to document why the lot is to be discarded and store the data supporting its decision in the appropriate repository.
Solutions involved	• 8 - i4Q^{DR}: Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines • 3 - i4Q^{BC} Blockchain Traceability of Data
Roles	Quality Inspector

Task ID	T28
Name	Discard lot
Description	If a lot is rejected it may have to be returned, destroyed or others.
Solutions involved	N/A
Roles	Inventory Team

A07 – Store product

Activity ID	A07
Name	Store product
Description	Once the production of an item has finished it has to be stored until it is required in a posterior production phase or, if it is a finished product, it is ready for transportation.
Constraints	The item or set of items are ready to be stored. The items will have to be available, once stored, for the next stage of the production process.
Effects	A product, finished or intermediate, is stored.
Triggers	The production of an item finishes.
Tasks	T30, T27, T32
Workflows	See Figure 10

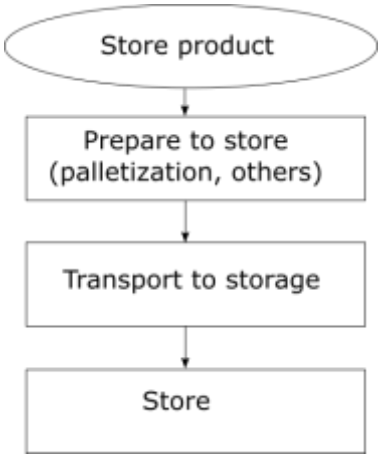

Figure 10. Workflow for Activity A07

Task ID	T30
Name	Prepare to store
Description	Prepare an item to be stored after its production has finished. This can involve putting the item in boxes, pallets or other.
Solutions involved	N/A
Roles	Inventory Team

Task ID	T27
Name	Transport to storage
Description	Load, transport an unload an item internally.
Solutions involved	N/A
Roles	Inventory Team

Task ID	T32
Name	Store
Description	Store an item until it is required in a new production phase or for being delivered.
Solutions involved	N/A
Roles	Inventory Team

A08 - Deliver an item

Activity ID	A08
Name	Deliver an item
Description	This activity spans the process of delivering an item, from its preparation in the storage until the item departs from the factory.
Constraints	There must be an item or set of items stored. These items must be the ones expected by the receiver.
Effects	The item is delivered to a customer or to another location

Triggers	Reception of a purchase order
Tasks	T33, T34, T35
Workflows	See Figure 11

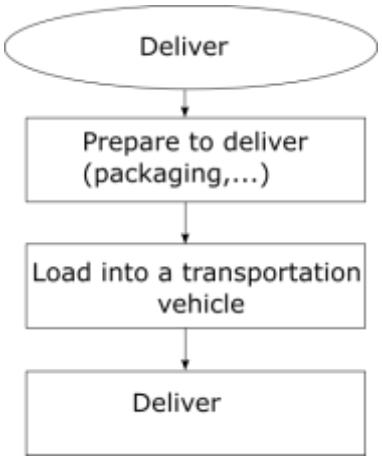

Figure 11. Workflow for Activity A08

Task ID	T33
Name	Prepare to deliver
Description	Prepare an item from the storage for being delivered. This can imply further packaging, visual inspection or other.
Solutions involved	N/A
Roles	Inventory Team

Task ID	T34
Name	Load into a transportation vehicle
Description	The products are loaded and secured into a vehicle for its transportation.
Solutions involved	N/A
Roles	Inventory Team

Task ID	T35
Name	Deliver

Description	The transportation vehicle departs from the factory.
Solutions involved	N/A
Roles	Inventory Team

A09 – Product cost accounting

Activity ID	A09
Name	Product cost accounting
Description	This activity describes the process of analyzing the resulting cost of manufacturing an item due to imperfections during production.
Constraints	This process should be executed continuously and depends on the data generated by A00 and A01.
Effects	After gathering data relevant to the manufacturing process of an item, the evolving cost of production is identified and analyzed.
Triggers	On product or batch finished
Tasks	T36, T37, T38, T20
Workflow	See Figure 12

Figure 12. Workflow for Activity A09

Task ID	T36
Name	Prepare data
Description	Gather, clean and filter the appropriate data relevant to the production of an item or batch.
Solutions	• 09 - i4QDIT: Data integration and manipulation services

involved	• 01 - i4Q DQG: Data Quality Guidelines
Roles	Quality inspector

Task ID	T37
Name	Perform analysis
Description	Perform the main analysis of the production of an item or batch.
Solutions involved	• 19 - i4QPA: Prescriptive Analysis Tools
Roles	Quality inspector

Task ID	T20
Name	Store data: results and interpretation
Description	Store the results of the product cost analysis. These results are stored in a digital format that may depend on the context.
Solutions involved	• 8 - i4Q^{DR}:Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines • 3 - i4Q^{BC} Blockchain Traceability of Data
Roles	Quality manager, Quality inspector

A10 – Production scheduling

Activity ID	A10
Name	Production scheduling
Description	Once an order has been received, stock must be ordered if insufficient and a schedule proposed.
Constraints	A00 cannot begin without a schedule, therefore proper scheduling of production is essential.
Effects	A new production schedule is implemented
Triggers	On product order received
Tasks	T39, T40, T41, T42, T20
Workflow	See Figure 13

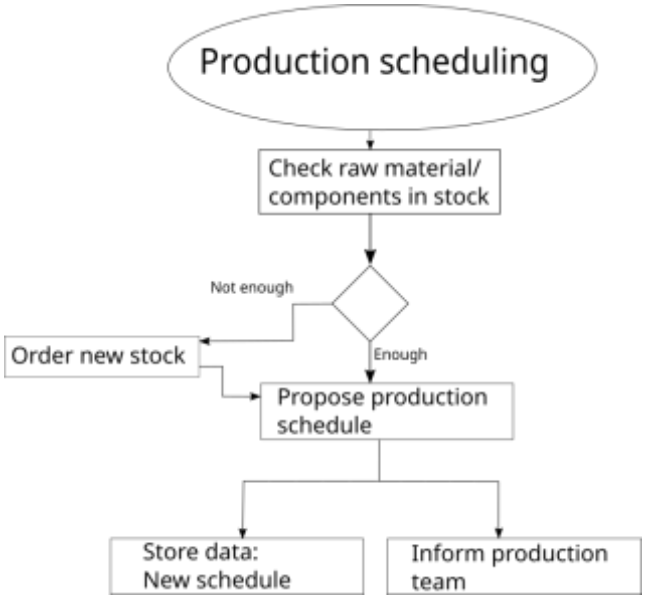

Figure 13. Workflow for Activity A10

Task ID	T39
Name	Check raw materials or components in stock
Description	Before a new production schedule can be designed, sufficient components must be in stock
Solutions involved	• 8 - i4Q^{DR}: Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines
Roles	Inventory team

Task ID	T40
Name	Order new stock
Description	If there is not enough stock, it must be ordered
Solutions involved	N/A
Roles	Inventory team

Task ID	T41
Name	Propose production schedule
Description	Considering all related variables (deadlines, stock, productive capacity, maintenance etc.) a new production schedule must be proposed and accepted.
Solutions	• 15 - i4Q^{IM}: Infrastructure Monitoring • 17 - i4Q^{PQ}: Data-driven Continuous Process Qualification

involved	
Roles	Production scheduler

Task ID	T20
Name	Store data: new schedule
Description	Store the new schedule in the system.
Solutions involved	• 8 - i4Q^{DR}:Data Repository • 7 - i4Q^{DRG}: Data Repository Guidelines • 3 - i4Q^{BC} Blockchain Traceability of Data
Roles	Production scheduler

Task ID	T42
Name	Inform production team
Description	The production team must be informed about the new production schedule
Solutions involved	N/A
Roles	Production scheduler

4.2 i4Q solutions involved in the proposed activities

Table 2 shows in a visual way the solutions that can be related to the different tasks proposed in the frame of the different activities. As can be noticed, not all the tasks involve solutions and not all the solutions are involved. Activities and tasks respond to the needs expressed by the different use cases and the analysis performed in the business viewpoint. From our understanding, the main reason for having solutions that are not involved in any task is that they are to be considered at a different level, as infrastructure solutions are not necessarily seen by/in the activities. This applies, for instance, to those solutions related to cybersecurity or networking.

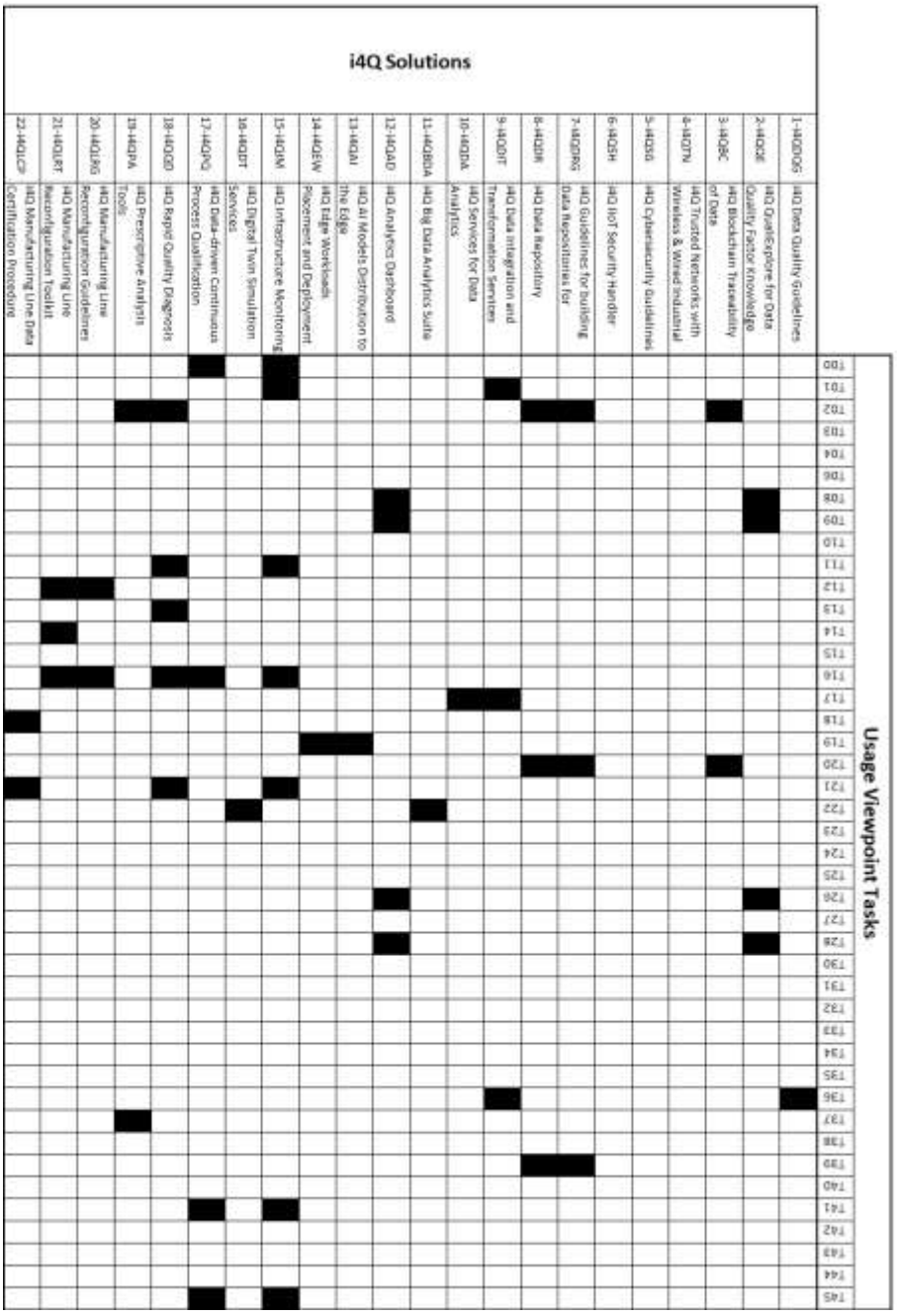

Table 2. i4Q solutions involved in each task.

5. Conclusions

This document presents the analysis related to the usage viewpoint for i4Q. Its main focus on this document has been on identifying the parties and roles that will execute the different tasks, the tasks composing the different activities and the activities itself.

Although the identification of parties and roles started already in the **D2.3 Business Viewpoint**, this deliverable has established the bridge between them (the proposed parties and roles) and the tasks to be performed.

Regarding the tasks and activities, 11 different activities composed by a collection of 41 different tasks have been identified, with the corresponding description of their constraints and effects, in the case of activities, and i4Q solutions involved or responsible roles, in the case of tasks. These activities and tasks cover, to the best of our understanding, the needs identified in the different use cases and in the **D2.3 Business Viewpoint** document. Similarly, it is important to note that not all the i4Q solutions are related to one of the proposed tasks, as can be seen in **Table 2**. The main reason for this is that there are solutions whose use must be identified at a higher level, possibly at the infrastructural one, as solutions related to networking or cyber security.

6. References

[1] Bhattarai, S.; et al, "The Industrial Internet Reference Architecture v 1.9," Industry IoT consortium, 2019.

[2] i4Q, "D2.3 Business Viewpoint," 2021.

[3] "Guideline, EPCIS and Core Business Vocabulary Implementation," [Online]. Available: https://www.gs1.org/standards/epcis. [Accessed 09 2021].

7. Appendix I

Table 3 contains the mapping of the tasks (see Section 3, Table 1) identified in this deliverable and the Core Business Vocabulary (CBV) of the EPCIS Standard [3]. The interlink of the tasks in section 3 and the CBV as information sub-set of an EPCIS event message was assessed as suitable approach for integration of the standard.

EPCIS is an acknowledged standard for supply chain management and an essential part of interoperable product tracking systems (e.g., using Radio Frequency Identification). It uses business steps to describe product-related events and some of these steps match with the tasks described above. The mapping can indicate opportunities for aligning the i4Q framework and the EPCIS standard to harmonize the naming of tasks within the i4Q software tools (provided they refer to tasks directly). This mapping may also serve as a useful approach for a data tracking method as part of a data quality management process (see Task 3.1).

The mapping in the table refers specifically to the CBV as part of an EPCIS event message that contains the information what, when, where and why of an event. A short example of an EPCIS compliant message payload can be found after the following table.

Task Id	Task - Name	EPCIS – CBV (Core Business Vocabulary)
T00	Produce (manufacture, build, ensemble, etc.) an item (part, product, etc.)	"assemble", "transforming" (depreciated) *Explicit Example of the payload of the CBV-based EPCIS event (see below table):* *urn:epcglobal:cbv:bizstep:assemble* *urn:epcglobal:cbv:bizstep:transforming*
T01	Sense data during the item production process	"inspecting", "other"
T02	Predict the quality of an item in production time	"inspecting", "other"
T03	Select samples	"commissioning"
T04	Manually check the quality of an item	"inspecting", "other"
T06	Compare quality measures of an item against reference quality measures	"inspecting", "other"
T08	Admit the item	"inspecting", "other"
T09	Reject the item	"inspecting", "other"
T10	Correct the item	"repairing"
T11	Decide whether to modify machine parameters	"repairing", "other"
T12	Propose new values for machine parameters	"repairing", "other"
T13	Decide if the problem can be solved with automatic changes	"other"

Task Id	Task - Name	EPCIS – CBV (Core Business Vocabulary)
T14	Automatically modify machine parameters	“repairing”, “other”
T15	Manually modify machine parameters	“repairing”, “other”
T16	Propose the shutdown of the machine or the production process	“other”
T17	Compute derived quality evaluation data (e.g., FFT)	“inspecting”, “other”
T18	Maintain the production equipment (disassemble, calibrate, repair, reassemble, test, etc.)	“repairing”
T19	Publish AI/ML Model	“other”
T20	Store Data	“inspecting”, “other”
T21	Stop production	“other”
T22	Train a model with the provided data	“other”
T23	Reception of raw matter / goods	“arriving”
T24	Ensure legal obligations from AI	“other”
T25	Storage of raw materials / goods	“storing”
T26	Admission of raw materials / goods	“inspecting”, “other”
T27	Transportation to storage	“transporting”
T28	Discard lot	“destroying”
T30	Prepare to store	“entering_exiting”
T32	Store	“storing”
T33	Prepare to deliver	“staging_outbond”
T34	Load into a transportation vehicle	“loading”
T35	Deliver	“departing”
T36	Prepare data	“inspect”, “other”
T37	Perform analysis	“inspect”, “other”
T38	Interpret results	“inspect”, “other”
T39	Check raw materials or components in stock	“stock_taking”
T40	Order new stock	“stocking”
T41	Propose production schedule	“other”
T42	Inform production team	“other”

Task Id	Task - Name	EPCIS – CBV (Core Business Vocabulary)
T44	Request rescheduling of production	“other”
T45	Check if scheduled or unscheduled maintenance is needed	“inspecting”, “other”

Table 3. Relation between the proposed tasks and EPCIS CBV

Example of an EPCI compliant message payload with integrated core business vocabulary (see bold data field in “Why” section):

```
{
  // Event Type
  "isA": "ObjectEvent",

  // When
  "eventTime": "2005-04-03T20:33:31.116-06:00",
  "eventTimeZoneOffset": "-06:00",

  // What
  "epcList": [
    "urn:epc:id:sgtin:0614141.107346.2017",
    "urn:epc:id:sgtin:0614141.107346.2018"
  ],

  // Where
  "readPoint": "urn:epc:id:sgln:0614141.07346.1234",

  // Why
  "action": "OBSERVE",
  "bizStep": "urn:epcglobal:cbv:bizstep:assemble",
  "bizTransactionList": [
    {
      "type": "urn:epcglobal:cbv:btt:po",
      "bizTransaction": "http://transaction.acme.com/po/12345678"
    }
  ]
}
```

On first sight, the mapping in the table above, lead the reader of a majority of “other” to the conclusion that the CBV might not be suitable or might have shortcomings to express a certain task via EPCIS events. Nevertheless, the current evaluation of the EPCIS releases show the reasonable application of the standard, since CBV is a subset of information in an EPCIS event and can be properly expressed in other fields of the event structure, but still has its main information injection in the “bizStep” data field. Still, future tasks might lead to re-evaluation of the standard and trigger a new release for more detailed vocabulary in CBV, since developments and complexity in industry 4.0 applications get more sophisticated.