Ecosystem for COllaborative Manufacturing PrOceSses – Intra- and Interfactory Integration and AutomaTION
(Grant Agreement No 723145)

D2.5 Lessons Learned and Updated Requirements Report I

Date: 2017-11-28

Version 1.0

Published by the COMPOSITION Consortium

Dissemination Level: Public

Co-funded by the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement No 723145

Document control page

Document file: D2.5 Lessons Learned and Updated Requirements Report I_V1.0.docx
Document version: 1.0
Document owner: IN-JET

Work package: WP2 – Use Case Driven Requirements Engineering and Architecture
Task: T2.4 – Evolutionary Requirements Refinement
Deliverable type: R

Document status: ☒ Approved by the document owner for internal review
☒ Approved for submission to the EC

Document history:

Version	Author(s)	Date	Summary of changes made
0.1	Helene Udsen (IN-JET)	2017-11-15	ToC and Chapters 2, 3, 5, 6 and Appendix B
0.2	Helene Udsen, Peter Rosengren (CNET), Mathias Axling (CNET)	2017-11-23	Chapters 1 and 7 added, Chapter 4 content added, various Tables and other content added/updated and edited.
1.0	Helene Udsen	2017-11-28	Reviewer comments addressed. Final version submitted to the European Commission

Internal review history:

Reviewed by	Date	Summary of comments
Martina Beer (FIT-WI)	2017-11-24	Approved with comments and suggestions regarding consistency and further explanations
Giuseppe Pacelli (ISMB)	2017-11-27	Approved with minor comments

Index:

1 Executive Summary

This deliverable provides an overview of the requirements engineering work performed in the first half of the project through the iterative process adopted for the COMPOSITION project.

The deliverable documents the Lessons Learned and changes in the requirements compared to the information provided in *D2.2 Initial Requirements Specification*.

A further update will be provided in *D2.6 Lessons Learned and Updated Requirements Report II*, which is due in M28 (December 2018).

1.1 Research and Development Methodology

The requirements derived from the use cases will be enhanced in an iterative process to assure that the user-centred approach outlined in the DoA is followed in all phases of the project.

Lessons Learned are part of COMPOSITION's commitment to Knowledge Management, promoting recurrence of successful outcomes and precluding the recurrence of unsuccessful outcomes.

Lessons are learned during project research and technology development work, during testing and integration and as a part of the validation of project prototypes and can thus be learned throughout the project work.

The Lesson Learned process adopted by COMPOSITION has six steps: Collection, verification, storage, dissemination, reuse and identification of improvement opportunity.

For collection and storage, a repository has been established in the COMPOSITION Confluence Wiki.

1.2 Lessons Learned and Requirements Engineering

A total of 26 Lessons Learned has been reported in the first cycle. Compared with the list of requirements in *D2.2 Initial Requirements Specification*, 37 requirements have been added. Not all of these are the result of the Lessons Learned; some are technical requirements derived from new or existing user requirements. All requirements have been updated, though the majority not in substance, but rather as a result of adding Custom Labels for various purposes, e.g., filtering/structuring. Fourteen of the original requirements have been rejected.

As of mid-November 2017, the COMPOSITION JIRA repository contains 125 active requirements, 8 of which have been implemented, while 70 have status "Part of Specification", 17 have passed QC check and 30 are Open. The group "Part of Specification" covers many requirements that have been partially implemented.

All requirements have been reassessed, and if appropriate, Requirement Priority has been changed to reflect the priority of the use case(s) they are part of. With minor deviations within each group, Requirement Priority 'Major' includes requirements in the Tier 1 Use Cases (approx. 64%), 'Medium' the requirements in the Tier 2 Use Cases (approx. 21%), and the rest are Tier 3.

With the further development of the COMPOSITION architecture, the list of Components has been extended and now comprises 23 entities. This includes five added components: Building Management System, Data Collection System, Marketplace, Marketplace UI and Service Catalog.

Through the "Component" field in the requirement definition Volere template, all requirements are associated with one or more components, providing a structural overview relative to the COMPOSITION architecture described in *D2.3 The COMPOSITION Architecture Specification I*.

1.3 Innovations

To ensure that the project has strong and continued focus on successful implementation of creative ideas, the COMPOSITION consortium has created a dedicated and strategic structure for managing the innovation activities.

Three additional Innovations been identified: I-06 Deep Learning Toolkit, I-07 Process-Oriented Monitoring Framework and I-08 Big Data Analysis Service.

2 Introduction

The aim of the COMPOSITION project is to create a digital automation framework, the COMPOSITION Integrated Information Management System (IIMS), that optimises manufacturing and business processes by exploiting existing data, knowledge and tools to increase productivity and adapt dynamically to changing market requirements. This technology acts as the technical operating system for business connections between factories and their suppliers.

Furthermore, COMPOSITION opens a new space for third party entities to actively interact in the supply chain, e.g., by providing services to improve cycle time, cost, flexibility or resource usage. In addition to the supply chain improvements, also processes inside the company will be addressed and optimised.

2.1 Purpose, context and scope of this deliverable

This deliverable provides an overview of the requirements engineering work performed in the first half of the project through the iterative process adopted for the COMPOSITION project.

The deliverable documents the Lessons Learned and changes in the requirements compared to the information listed in *D2.2 Initial Requirements Specification*, including additions to the list of Innovations.

A similar update will be provided in *D2.6 Lessons Learned and Updated Requirements Report II*, which is due in M28 (December 2018).

2.2 Content and structure of this deliverable

Chapter 3 briefly reiterates the research and development methodology applied and describes the COMPOSITION approach to Lessons Learned.

Chapter 4 lists the Lessons Learned and the change in requirements based on analysis of the Lessons. The content is organised per Work Package (WP).

Chapter 5 provides various statistical information on the present list of COMPOSITION requirements in the JIRA Repository, while Chapter 6 introduces Innovations reported since the original list in D2.2.

Appendix A contains the full, updated list of COMPOSITION requirements, and Appendix B provides details of presently identified COMPOSITION Innovations.

2.3 List of Abbreviations and Acronyms

Acronym or Abbreviation	Meaning
AMQP	Advance Message Queuing Protocol
AMS	Agency Management Services
BMS	Building Management System
DF(M)	Digital Factory (Model)
DoA	Description of Action
EFFRA	European Factories of the Future Research Association
IIMS	Integrated Information Management System
LL	Lesson Learned
MES	Manufacturing Execution System
MQTT	Message Queuing Telemetry Transport
PCBA	Printed Circuit Board Assembly
PLC	Programmable Logic Control
QC	Quality Control

Acronym or Abbreviation	Meaning
RPM	Revolutions Per Minute
RQ	Requirement
RTD	Research and Technology Development
UC	Use Case
WP	Work Package

3 Research and Development Methodology

3.1 Re-Engineering of Requirements

As the foundation for COMPOSITION is a use case driven requirement engineering process, the scenarios, the initial set of requirements, the implementations and the prototype pilots are going to be refined during the next steps of the project, also reflecting the continued analysis that has resulted in modifications of the originally defined use cases. The requirements will be enhanced in an iterative process to assure that the user-centred approach outlined in the DoA is followed in all phases of the project.

The requirements serve as a reference to measure if the development within the project is in line with the desired functionalities and properties. Using the JIRA tool to manage the requirements and the Volere template to document them ensures that all important aspects of requirements are carefully addressed and that the methods applied have proven their value in practical work. Most importantly a *fit criterion* is defined which makes the requirements operational and provides a measure for testing if the requirements are met.

A user-centred approach implies iterative cycles in a project. In COMPOSITION two main cycles are planned for the project lifetime, aiming at validating and evaluating prototypes of individual components and their integration in the complete system, both for the intra-factory value chains and the inter-factory supply chains.

The entire process and methodology are described in detail in *D2.2 Initial Requirements Specification*.

As part of this process, each Work Package (WP) continuously analyses and reports their development results, research and technology development (RTD) experiences, Lessons Learned in the development and integration work and other relevant knowledge gained during the development work.

3.2 The COMPOSITION Approach to Lessons Learned

Lessons Learned are a principal component of a project culture committed to Knowledge Management. Lessons Learned help support project goals in the RTD work of:

- Promoting recurrence of successful outcomes
- Precluding the recurrence of unsuccessful outcomes.

As part of the continuous improvement programme adopted by COMPOSITION, a systematic and continuous collection, indexing and dissemination of Lessons Learned is undertaken in WP2.

This section will establish criteria for the Lessons Learned process in COMPOSITION and discuss how to turn Lessons Learned into Lessons Applied.

Lessons are learned during project RTD work, during testing and integration, as a part of the validation of project prototypes and during literature search and technology watch. Lessons can thus be learned throughout the project work. As such, Lessons Learned constitute both individual and organisational knowledge and understanding gained by experience, either negative (missed targets, solutions that do not work as expected, wrong choice of technology) as well as positive (easier implementation than expected, faster response time, more interoperable devices than expected).

A workable Lessons Learned process first of all requires a definition of the term "lesson". A Lesson in COMPOSITION is characterised as follows:

- It must be significant in terms of the project progress and ability to meet its goal
- It must be valid, i.e., the experience gained must be repeatable
- It must be applicable to the COMPOSITION project
- It may contain or address pertinent info
- It may provide information of interest.

Not all experiences will qualify as being Lessons Learned. It is important, for example, that reported Lessons Learned not merely restate existing information and existing experiences not related to COMPOSITION work.

The Lesson Learned process has six steps:

- Collection
- Verification
- Storage
- Dissemination
- Reuse
- Identification of improvement opportunity.

Collection

The collection process focuses on collecting Lessons Learned from many sources internal and external to the project. The collection will be undertaken in all Work Packages.

WP2 will collect Lessons Learned from the iterative requirements engineering process, which can be reused to improve the performance and efficiency of future iterations.

The RTD work undertaken in WP3-7 will provide a large amount of Lessons Learned, by virtue of the many researchers participating in this work and the many small and large experiences gained individually and as teams. The challenge here is to identify and properly describe the Lessons Learned and filter them according to significance, validity, and applicability to the project.

The evaluation of the pilots in WP8 will obviously provide a range of experiences that can be classified as Lessons Learned, as will the endeavours of WP9 of identifying sustainable business ecosystems for deployment.

Verification

Verifying the collected Lessons according to established standards is the second step in the process. All Lessons Learned must be verified for correctness, significance, validity, and applicability. The verification will be performed by the WP2 team together with the Technical Manager, the Innovation Manager and the involved WP leaders. The Technical Manager will decide to add and remove Lessons Learned as necessary.

Some of the criteria that may be used for verification are:

- Relationship with the project flow
- Relevance to the project outcome
- Significance in terms of quality parameters such as robustness, ease of use, functionality
- Research aids used
- Systemic process issues
- Credibility or reputation of the originator.

Storage

A Repository for Lessons Learned has been created in the COMPOSITION Confluence Wiki, which is hosted by FIT as part of the collaborative space. A screenshot is shown in Figure 1.

The Lessons Learned repository will act as an organisational memory for experiences encountered by all project members during the course of the project.

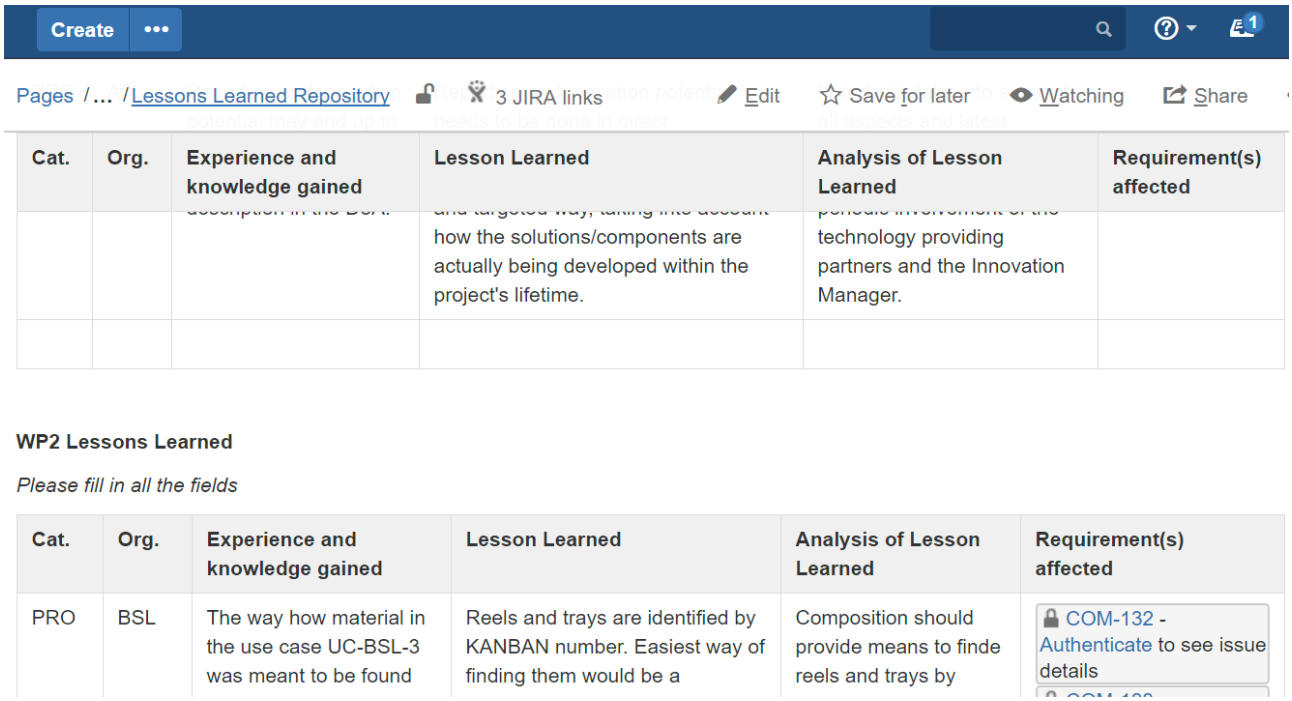

Figure 1: Confluence Wiki for collection and storage of Lessons Learned

Dissemination

Informing the involved participants is a very important part of the process. All project workers are encouraged to consult the Lessons Learned repository, not only for the purpose of reporting, but also to continuously take note of Lessons Learned by other project partners.

Reuse

The COMPOSITION project encourages and promotes Lessons Learned to be used by other than the submitter. The WP leaders have a responsibility to consult the Lessons Learned repository regularly and at least before any major decision affecting the development or project outcome is to be made. The WP leaders are obliged to take part in the engineering process of requirements, which is based on a timely assessment of the reported Lessons Learned.

Identification of improvement opportunity

The last step in the process relates to the identification of incremental and innovative improvements that will measurably enhance the COMPOSITION requirement specification.

This analysis will lead to new and/or updated requirements, which will be incorporated into the JIRA repository. As for the existing requirements, the new and updated requirements will be processed along the agreed JIRA requirement workflow by the WP2 team and WP leaders.

4 Lessons Learned and Requirements Engineering

This chapter contains the Lessons Learned collected in the first 18 months of the project and the subsequent analysis. To facilitate referring to individual Lessons Learned, they have been named LL followed by the relevant Work Package number and Lesson number (as they appear in the Confluence Wiki repository), e.g., LL-WP1-1. The process results in the identification of a series of improvement opportunities and the need for new, changed or rejected requirements (RQs).

The Lessons and the subsequent analysis are grouped per Work Package. The changes and updates to the requirements resulting from the Lessons Learned are listed and discussed for each Work Package.

A total of 26 Lessons Learned has been reported in the first cycle. Compared with the list of requirements in *D2.2 Initial Requirements Specification*, 37 requirements have been added. Not all of these appear from the Lessons Learned; some are technical requirements derived from new or existing user requirements. All requirements have been updated, though the majority not in substance, but rather as a result of adding Custom Labels for various purposes, e.g., as reported in LL-WP1-3 below. Fourteen of the original requirements have been rejected.

The full list of requirements is attached in Appendix A.

4.1 Lessons Learned in WP1

The work undertaken in WP1 involves the managing of the COMPOSITION project. FIT is the WP leader, and three Lessons Learned have been collected and verified from this WP.

Table 1: Lessons Learned in WP1

Org. LL ID	Experience and knowledge gained	Lesson Learned	RQs Affected
FIT LL-WP1-1	Technical developments can become rather decoupled from the scenario and use case definitions, although these definitions are documented and communicated	Documenting scenarios and use cases is not enough to avoid that the implementation becomes technology-driven	May affect several RQs, directly or indirectly
ATL LL-WP1-2	Reporting on Innovation potential may end up being rather generic, even though the process is described in detail in the DoA and other documents.	Reporting on Innovation potential needs to be done in direct collaboration with the technology developing partner(s) in an iterative and targeted way, taking into account how the solutions/components are actually being developed over the lifetime of the project.	
IN-JET LL-WP1-3	The number and atomic nature of the Volere requirements in the JIRA repository make it difficult to get an overview	It can be helpful to define different ways of grouping the requirements.	All

4.1.1 Analysis of Lessons Learned

LL-WP1-1: To make implementations more scenario-driven, the technical team can go through the scenarios in dedicated sessions and then discuss together how to develop technology accordingly.

LL-WP1-2: To take into account all aspects and latest updates, an iterative process is necessary, with the periodic involvement of the technology-providing partners and the Innovation Manager.

LL-WP1-3: One possible way to do this is to assign each requirement to the Work Package responsible for the implementation.

4.1.2 New/Updated/Rejected Requirements

No requirements have been added or rejected.

As a consequence of LL-WP1-3, all requirements have been updated with Custom Labels. As mentioned above, this change has not affected the substance of the requirements.

4.2 Lessons Learned in WP2

Work Package 2 manages the requirements engineering process and architecture development. IN-JET is the WP leader, and seven Lessons Learned have been collected and verified from this WP.

Table 2: Lessons Learned in WP2

Org. LL ID	Experience and knowledge gained	Lesson Learned	RQs Affected
NXW LL-WP2-1	The challenges and how the matchmaking works must be more clearly described in Use Case UC-NXW-1 (Decision support over marketplace)	Only listing use case "to-be" steps is not enough to determine the challenges and the specific internal mechanisms (e.g., matchmaking)	
KLE LL-WP2-2	In order to decide when to fix a breakdown or prioritize breakdowns, an automated system with real-time data and DSS tools, should be developed to detect failures before they occur (UC-KLE-1 Maintenance Decision Support)	Breakdowns can be detected by monitoring vibration	COM-4 COM-9 COM-73 COM-93 COM-95 COM-97 COM-99 COM-100 COM-101 COM-125
KLE LL-WP2-3	Overlapping has been detected in Use Cases UC-KLE-4, UC-KLE-5 and UC-KLE-6. These use cases can be combined into one revised Use Case: UC-KLE-4 Scrap metal collection and bidding process	Use cases should be defined to illustrate different aspects of the involved processes.	COM-146
CNET LL-WP2-4	Initial design focus is on development of standalone components	Risk of late system integration and of system qualities like extensibility, scalability and maintainability becoming an afterthought	
CNET LL-WP2-5	Early design decisions on deployment and communication protocols were made. (Docker, MQTT, AMQP)	Deciding on the deployment and communication platforms has made test deployment and integration work easier to manage	
CNET LL-WP2-6	Inception design (from the DoA) did not specify some components, e.g., for operational management or configuration	The architecture needed additional components to cover system configuration and monitoring	
ATL LL-WP2-7	The challenges and how the matchmaking works must be more clearly described in Use Case UC-NXW-1 (Decision support over marketplace)	Broad familiarity with relevant standards in the COMPOSITION domains is a must when developing solutions and tools	

4.2.1 Analysis of Lessons Learned

LL-WP2-1: The Use Case has been revised, explicitly describing the unclear parts.

LL-WP2-2: COMPOSITION IIMS should collect information about actual performance (real-time) and history of performance. COMPOSITION should analyse and evaluate the information gathered in order to suggest solutions

LL-WP2-3: The combination of UCs has addressed the overlaps and is now describing a complete and integrated Use Case.

LL-WP2-4: The risks are mitigated by developing technical scenarios to drive design for these system aspects

LL-WP2-5: It will be possible to build on this to describe deployment scenarios for production early on. This could also help exploitability.

LL-WP2-6: These components have been added and will be designed. However, implementation may be deferred to the exploitation phase (to ensure compatibility with off-the-shelf products, if relevant).

LL-WP2-7: To ensure universal applicability it is essential to develop technical solutions based on widely used standards

4.2.2 New/Updated/Rejected Requirements

Two requirements have been created: “COM-125 Equipment Monitoring Screen is able to display predictive maintenance information for the machines where it is available” and “COM-146 The system shall allow the user to provide specifications for bidders for scrap metal”.

Requirements COM-4, COM-9, COM-73, COM-93, COM-95, COM-97, COM-99, COM-100 and COM-101 have been updated.

No requirements have been rejected.

4.3 Lessons Learned in WP3

WP3 is in charge of the work on modelling and simulation. CERTH is the WP Leader, and three Lessons Learned have been collected and verified from this WP.

Table 3: Lessons Learned in WP3

Org. LL ID	Experience and knowledge gained	Lesson Learned	RQs Affected
CERTH LL-WP3-1	Simulation and forecasting tool will make predictions using real time data	Though many different fill level sensors are commercially available, they may be unsuitable in COMPOSITION because of the nature and handling of the scrap	Several, indirectly
CERTH LL-WP3-2	Real time data should be described in a common format	A common format for sensor data representation and exchange has not been decided	COM-149
ATL LL-WP3-3	Response strategies need to defined for Predictive Maintenance	Response strategies must be integrated	

4.3.1 Analysis of Lessons Learned

LL-WP3-1: Dedicated fill level sensors may need to be developed.

LL-WP3-2: OGC[1] standards for sensor data will be used. Selection of JSON or XML formats is under examination.

LL-WP3-3: Integration of response strategies with current systems is necessary.

4.3.2 New/Updated/Rejected Requirements

New requirement “COM-149 COMPOSITION sensors' data should be described in a common format” has been created.

Additionally, two functional requirements have been created:

COM-114 Equipment representation in IIMS can be adapted to line moves
COM-123 To resolve an equipment issue a given set of conditions must be met

[1] Open Geospatial Consortium, www.opengeospatilal.org

Two existing requirements, COM-75 and COM-105, have been rejected as Duplicates.

4.4 Lessons Learned in WP4

The work undertaken in WP4 encompasses security issues related to managing and exchanging of manufacturing data. ATOS is the WP Leader, and three Lessons Learned have been collected and verified from this WP.

Table 4: Lessons Learned in WP4

Org. LL ID	Experience and knowledge gained	Lesson Learned	RQs Affected
ATOS LL-WP4-1	The joint use of manual procedures and tools that simplify some tasks can lead to safer performance	It is not always the best solution to perform all tasks with simple and easy-to-use tools as this may put security at risk	May indirectly affect several RQs
CNET LL-WP4-2	Blockchain is still not a plug-and-play technology and requires a substantial amount of low-level configuration	Open source platforms are not always as easy to re-use as one expects. They often are targeting developers and not integrators	
CNET LL-WP4-3	The content of a Blockchain ledger is not easily communicated to end users	Even a simple user interface and ledger content rendering provides an enhanced user experience	

4.4.1 Analysis of Lessons Learned

LL-WP4-1: Replacing all manual procedures with software tools and solutions may require relaxing of security policies.

LL-WP4-2: There is opportunity to develop easy-to-use tools to allow integration of Blockchain technology into manufacturing applications.

LL-WP4-3: Visualisation tools for the distributed ledger are needed.

4.4.2 New/Updated/Rejected Requirements

No requirements have been added, updated or rejected.

Several requirements related to physical security are under consideration, soon to be added to the JIRA repository.

4.5 Lessons Learned in WP5

WP5 deals with technologies for interoperability and data analysis. ISMB is the WP Leader, and one Lesson Learned has been collected and verified from this WP.

Table 5: Lessons Learned in WP5

Org. LL ID	Experience and knowledge gained	Lesson Learned	RQs Affected
FIT LL-WP5-1	BSL technicians replace oven fans if they hear abnormal noise.	Predicting necessary replacement of oven fans can be facilitated by monitoring the parameters fan speed, noise and power consumption.	COM-140 COM-141

4.5.1 Analysis of Lessons Learned

LL-WP5-1: Building on the knowledge of experienced operators has been instrumental in defining the data needed to incorporate an automated warning into the system.

4.5.2 New/Updated/Rejected Requirements

As a consequence of this Lesson Learned, two new requirements “COM-140 The COMPOSITION team shall define the limits of fan noise, RPM and power consumption, which define when an alarm is raised” and “COM-141 Fan alarms shall be raised if RPM, power consumption and noise of the fan exceed their limits” have been created.

Additionally, 27 functional requirements have been created in WP5:

COM-108 The system shall integrate all IIMS and Marketplace HMIs in one application
COM-112 The system shall visualize idle machines in KLE's production process
COM-115 The equipment monitoring overview screen is able to show the relevant information on the equipment in real time
COM-116 The equipment monitoring overview screen is able to show the flow of the product (PCBAs) through the lines in real time
COM-117 Details about equipment can be accessed when equipment is selected on overview screen
COM-118 System should allow only logged in users to create, edit and view comments related to downtime log
COM-119 Persons with a viable login can define their equipment subscriptions
COM-121 A downtime log should be available for each equipment
COM-122 Equipment status changes automatically based on light tower and alarm information
COM-124 Users on the big visualisation screen are logged out automatically after defined time period and the view returns to the public overview screen
COM-127 Alarms/Notifications are forwarded to subscribers depending on their impact level
COM-128 Reminders for equipment resolution are issued
COM-129 System shall assist Technician in solving equipment issues
COM-130 Equipment issues can be reported manually
COM-131 Comments and updates can be added to the equipment Downtime log
COM-132 Reels and Trays shall be found by KANBAN and part number input
COM-133 The location of a reel or tray shall be visualized on a map with area names on it
COM-134 The material location sensor needs to be connected to a KANBAN and part number
COM-135 The system shall visualize the state of all equipment on one screen: up or down
COM-137 Asset must have a wireless tag that wakes up and reports when moved or triggered
COM-138 Where possible asset tags should be self-powered
COM-142 The system shall know how many assets can be processed by machine and by time
COM-143 The system shall know how many assets are currently processed by machine
COM-144 The line visualization shall compare the actual processed units to the target ones
COM-145 The system shall enable to stop production
COM-150 The HMI shall enable Technician to view and search for past equipment issues
COM-151 System shall allow recording and searching of equipment issues

Seven new requirements have been rejected: COM-126 failed QC check, COM-136 is a Duplicate, and COM-106, COM-107, COM-110, COM-111 and COM-113 were considered Out of Scope.

Twelve existing requirements have been rejected: COM-80 and COM-84 have been withdrawn by the Reporter, COM-5 and COM-10 failed QC check, COM-11, COM-23, COM-24 and COM-29, 36 are Duplicates, and COM-94, COM-102, COM-103 and COM-104 were considered Out of Scope.

4.6 Lessons Learned in WP6

In WP6, the collaborative ecosystem is developed. CNET is the WP Leader, and three Lessons Learned have been collected and verified from this WP

Table 6: Lessons Learned in WP6

Org. LL ID	Experience and knowledge gained	Lesson Learned	RQs Affected
CNET LL-WP6-1	Marketplace technical and business development has not been integrated	From an exploitation point-of-view, the business case for the proposed marketplace technical solution was not evident	

Org. LL ID	Experience and knowledge gained	Lesson Learned	RQs Affected
CERTH LL-WP6-2	Marketplace components such as the Agents and the Matchmaker should be able to manipulate Collaborative Manufacturing Services Ontology	In the initial design of requirements there are no components offering this functionality	COM-148
CERTH LL-WP6-3	The Matchmaker should match agents (requester and suppliers). Moreover, the Matchmaker should match a request with the best available offer.	The matchmaker should contain two sub-modules. One for agent level matching and other one for offer level matching	

4.6.1 Analysis of Lessons Learned

LL-WP6-1: To underpin exploitation potential, it is important that business development is aligned with the technical development.

LL-WP6-2: During the architecture design of COMPOSITION Marketplace an Ontology Query API component was added, and a first version developed.

LL-WP6-3: During the architecture design and implementation phases of the Matchmaker component, the need for two-level matching has been detected. The current version of the Matchmaker supports this two-level matching functionality.

4.6.2 New/Updated/Rejected Requirements

New requirement “COM-148 Matchmaker and Agents components should be able to access and manipulate Marketplace Ontology” has been created.

Three existing requirements have been rejected: COM-54 and COM-62 failed QC check, and COM-105 is a Duplicate.

4.7 Lessons Learned in WP7

WP7 is responsible for integration of internal and external elements. TNI-UCC is the WP Leader, and one Lesson Learned has been collected and verified from this WP.

Table 7: Lessons Learned in WP7

Org. LL ID	Experience and knowledge gained	Lesson Learned	RQs Affected
ATL LL-WP7-1	Like the plan provided by TNI-UCC, a structured high-level template for testing, installation and operation may be useful, also external to the project	An approach such as the one described in *D7.4 Test, Installation and Operation Plan Template I* may be valuable and reusable.	

4.7.1 Analysis of Lessons Learned

LL-WP7-1: On recommendation from the COMPOSITION reviewers, a dissemination campaign accentuating the availability of D7.4 was launched, catching the attention of EFFRA.

4.7.2 New/Updated/Rejected Requirements

No requirements have been added, updated or rejected.

4.8 Lessons Learned in WP8

WP8 will report on the pilots and their evaluation. At this stage of the project, no Lessons Learned have materialised from WP8.

4.9 Lessons Learned in WP9

WP9 develops business models and handles dissemination and exploitation. ATL is the WP Leader, and five Lessons Learned have been collected and verified from this WP.

Table 8: Lessons Learned in WP9

Org. LL ID	Experience and knowledge gained	Lesson Learned	RQs Affected
IN-JET LL-WP9-1	To facilitate exploitation planning, use cases need to be specific to real-life needs. If not, the business planning process becomes inconclusive, and the business cases unsustainable for further exploitation	Use cases need to be solidly anchored in the real world of the actors and end users. They must not solely represent what is feasible from a technical point of view, but also reflect non-functional requirements such as regulations and business practices	Many Inter-factory RQs
IN-JET LL-WP9-2	Market analysis and exploitation planning must be based on relatively solid knowledge of what the outcome of the project will be, or at least an affirmed understanding of the direction in which the project is developing	It is virtually impossible to make a realistic market description and analysis of market needs before an initial definition of the components and a common understanding of their functionalities are established	
ATL LL-WP9-3	Project interaction with EFFRA is very important	To increase visibility of COMPOSITION, it is valuable to invest in the interaction with EFFRA	
ATL LL-WP9-4	Exploitation potential is for all, but differs depending on the type of company or business	It is a challenge to achieve strong engagement from partners who are not technology-developing SMEs. The approach needs to be suitable for the different types of partners.	
CNET LL-WP9-5	The market for manufacturing software solutions is developing very dynamically	Existing vendors of MES, SCADA, PLC systems also want to be part of the Industrial IoT world and are currently adding such functionalities to their systems to avoid becoming "legacy" system.	

4.9.1 Analysis of Lessons Learned

LL-WP9-1: During development of scenarios and use cases, it is imperative that the end users are continuously feeding back input from their real-life experience. Any use case functionality must be measured against its applicability to the users' ecosystem and the use case must also include, or reflect, non-functional requirements

LL-WP9-2: The structure of the project should reflect the logical flow of market development and analysis processes and align with the associated sequence of work tasks. An initial definition of project outcomes and IPR should precede the definition of market description and analysis. Business modelling shall be preceded by a good understanding of value propositions from project outcomes, supported by the established market analysis. Finally, exploitation planning - jointly or individually - shall be based on the above. The process and the content and order of deliverables could be improved.

LL-WP9-3: To make COMPOSITION more visible in the industrial domain, it is important to establish and maintain good relations with EFFRA. It is particularly important to involve consortium members who are already EFFRA members.

LL-WP9-4: The templates for gathering exploitation information need to be different for the three categories of the partners in the project; i.e., technology providing partners/private companies, technology-providing academic partners and end users.

LL-WP9-5: New actors in the manufacturing market need to analyse their role in the developing ecosystems and be prepared to integrate their solutions at different levels in the value chain.

4.9.2 New/Updated/Rejected Requirements

No requirements have been added or rejected.

Many inter-factory requirements have been or will be (indirectly) affected.

5 Status Update for COMPOSITION Requirements

As of mid-November 2017, the JIRA repository contains 125 requirements, the status of which is depicted in Figure 2. Eight requirements have been implemented, 70 are Part of Specification, 17 have passed QC Check, while 30 have status Open. The majority of Open requirements are new requirements, and the group Part of Specification covers many requirements that have been partially implemented at this stage. Additionally, the repository contains 24 requirements that have been rejected, 9 as being Out of Scope, 8 as Duplicates and 2 that have been withdrawn. A further 5 requirements have failed the Quality Check; after revision, these may later become part of the COMPOSITION specification. The full list of requirements is attached in Appendix A.

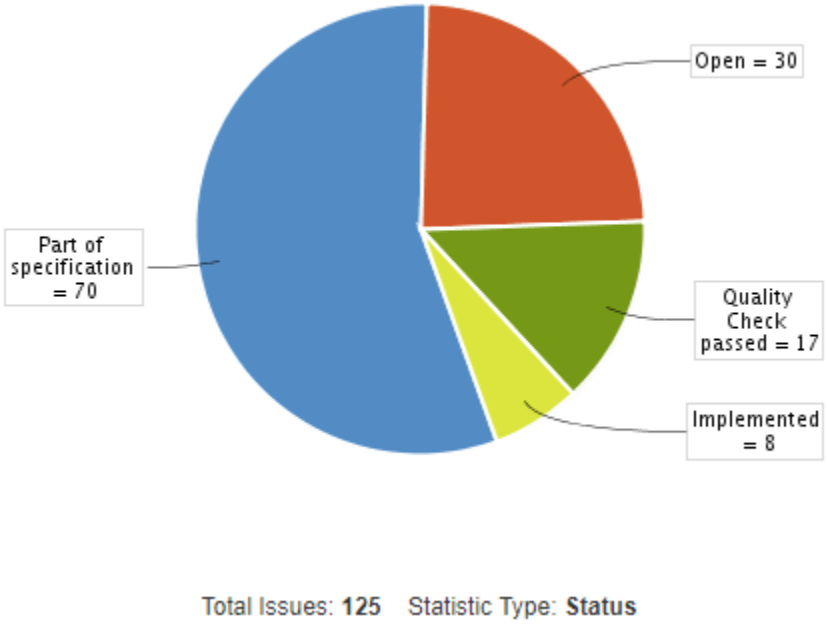

Figure 2: COMPOSITION requirements by Status

5.1 Requirement Types

Of these 125 requirements, there are 2 Constraints and 3 Project Issues, while 84 requirements are functional, and 36 are non-functional with sub-types as follows:

- Operational – 25
- Performance – 3
- Security – 5
- Usability – 2
- Not defined – 1.

5.2 Requirement Priority

Requirement Priority has been adjusted to align with the agreed priority of the associated Use Cases, as shown in Table 9. With minor deviations within each group, Requirement Priority 'Major' includes requirements in the Tier 1 Use Cases, 'Medium' the requirements in the Tier 2 Use Cases, and the rest in Tier 3. The distribution is illustrated in Figure 3, with approx. 64% having Priority Major and 21% Medium. The Blocker is "COM-27 Provide enough data for training artificial neural networks".

Table 9: Prioritisation of Use Cases

Tier	Use Case	Scenario	End User Importance
Tier 1	UC-BSL-2 Predictive Maintenance		High (BSL)
Very High Overall Priority	UC-KLE-1 Maintenance Decision Support	INTRA-2	Very High (KLE)
To be implemented by M18	UC-KLE-4 Scrap metal collection and bidding process	INTER-1	Very High (KLE)
	UC-ELDIA-1 Fill-level Notification – Contractual wood and recyclable materials manage	INTER-2	Very High (ELDIA)
Tier 2	UC-BSL-5 Equipment Monitoring and Line Visualisation	INTRA-1	Very High (BSL)
High Overall Priority	UC-KLE-2 Delayed Process Step		Very High (KLE)
Start to involve until M18	UC-BSL-3 Component Tracking	INTRA-3	High (BSL)
	UC-ATL-3 Searching for recommended solutions	INTER-4	Very High (ATL)
Tier 3	UC-KLE-3 Scrap Metal and Recyclable Waste Transportation		High (KLE)
Medium Overall Priority	UC-BSL-7 Automatic long term tracking of high value materials for physical security	INTRA-3	Medium (BSL)
Not to involve until M18	UC-BSL-4 Automatic Solder Paste Touch Up	INTRA-4	Medium (BSL)
	UC-KLE-7 Ordering raw materials	INTER-3	High (KLE)
	UC-ATL-1 Selling software/consultancy		High (ATL)
	UC-ATL-2 Searching for solutions	INTER-4	High (ATL)
	UC-ATL/NXW-1 Integrate external product into own solution		Medium (ATL, NXW)
	UC-NXW-1 Decision support over marketplace	INTER-5	High (NXW)

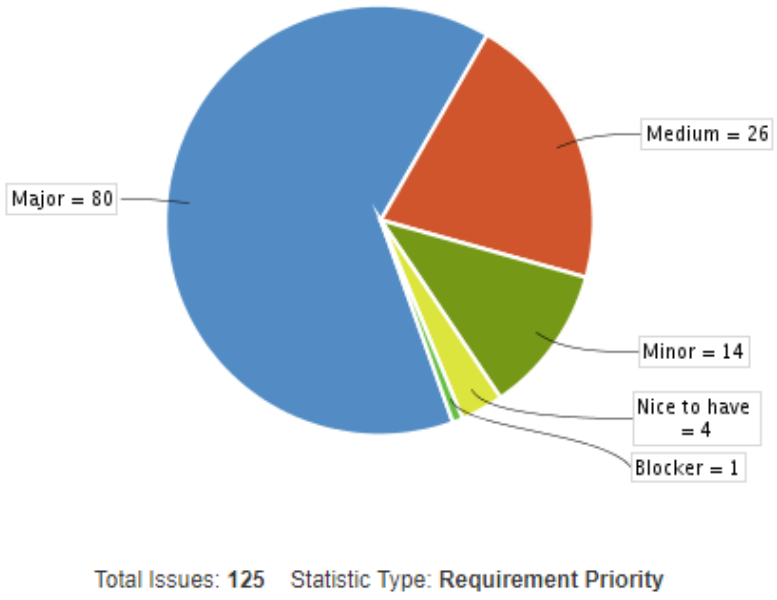

Figure 3: Requirement Priority distribution

5.3 Requirements per Work Package

Table 10: Number of Requirements per Work Package

Work Package	Number of Requirements
WP2	1
WP3	26
WP4	4
WP5	52
WP6	34

Unspecified	8

In view of providing a resource related overview, all requirements have been assigned a Custom Label indicating which Work Package is chiefly in charge of the development work. The distribution is shown in Table 10. The high number of requirements in WP5 reflects that this Work Package, among other tasks, covers the Advanced Human Machine Interfaces that are by nature associated with many end user requirements.

5.4 Requirements per Component

With the further development of the COMPOSITION architecture, the list of Components has been extended and now comprises 23 entities. These are shown below, with the new ones in italics.

- Access Control
- Advanced Human Machine Interfaces
- Authentication
- Big Data Analytics
- BlockChain Connector
- *Building Management System*
- *Data Collection System*
- Deep Learning Toolkit
- Intrafactory Interoperability Layer
- Manufacturing Big Data Storage
- Manufacturing Decision Support System
- Market Event Broker
- *Marketplace*
- *Marketplace UI*
- MatchMaker
- Modelling
- Ontology
- Real Time Multi- Protocol Event Broker
- Requestor Agent
- Security Information and Event Management
- *Service Catalog*
- Simulation and Forecasting Tool
- Supplier Agent.

An architectural overview of the components and their interactions is shown in Figure 4.

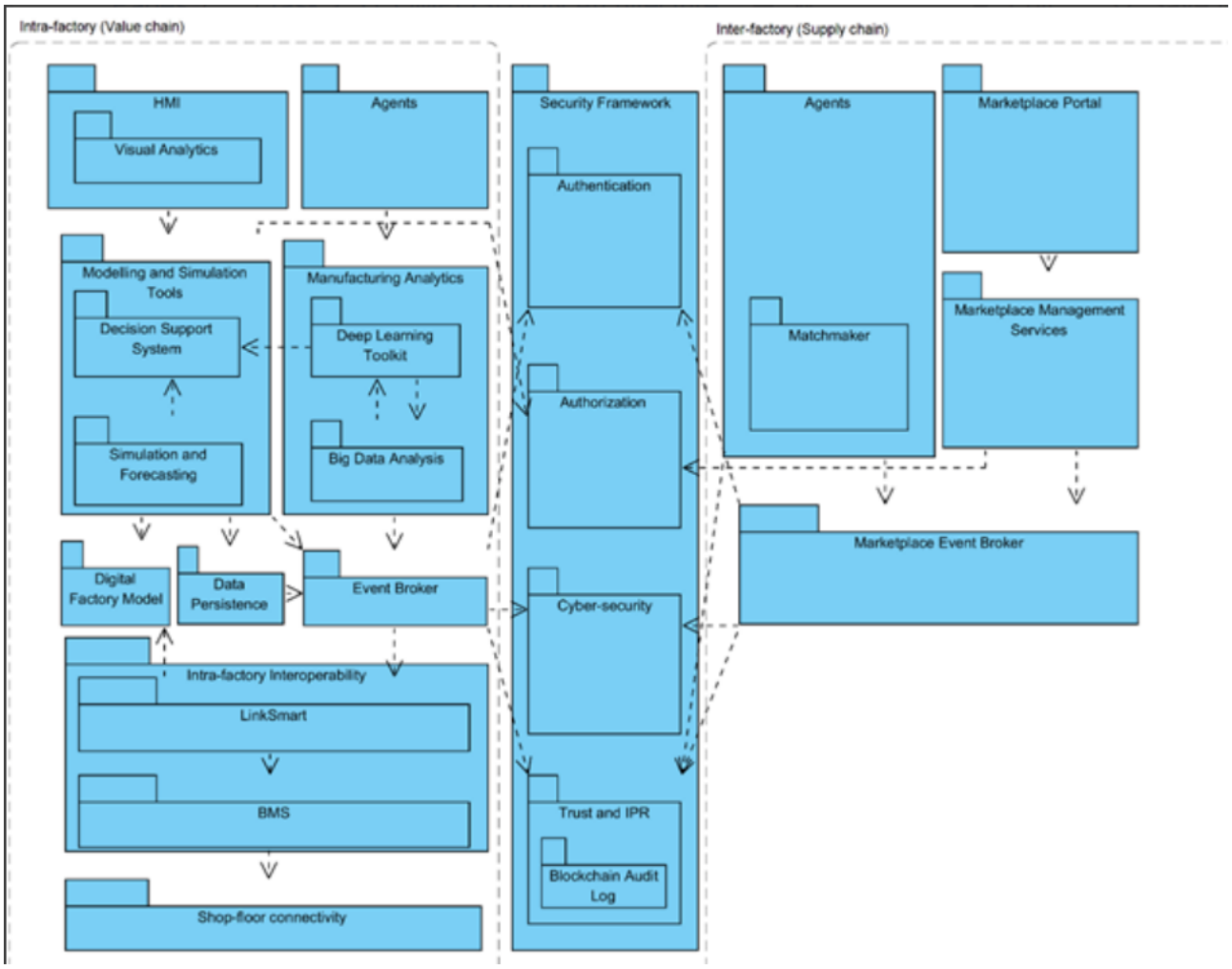

Figure 4: Architectural view of components

For more details, refer to *D2.3 The COMPOSITION Architecture Specification I*. The new components will be documented in *D2.4 The COMPOSITION Architecture Specification II,* due in M24 (August 2018).

Through the "Component" field in the requirement definition Volere template, all requirements are associated with one or more components, providing a structural overview relative to the COMPOSITION architecture.

The following sections summarise the relation between the components and the individual requirements, considering only those that do not presently have Status "Rejected" as described above. As many of the requirements are high-level, they are typically associated with more than one component, as is evident from the total number of requirements listed in Tables 11 through 33.

5.4.1 Access Control

The 10 requirements listed in Table 11 are associated with this component.

Table 11: Requirements for Access Control

Key	Summary	Status	Priority
COM-146	The system shall allow the user to provide specifications for bidders for scrap metal	Quality Check passed	Major
COM-139	All components with a public endpoint shall enforce authentication and authorization	Open	Major
COM-130	Equipment issues can be reported manually	Open	Minor
COM-124	Users on the big visualisation screen are logged out automatically after defined time period and the view returns to the public overview screen	Open	Medium
COM-119	Persons with a viable login can define their equipment subscriptions	Open	Minor

Key	Summary	Status	Priority
COM-118	System should allow only logged in users to create, edit and view comments related to downtime log	Quality Check passed	Medium
COM-90	Ecosystem components should be deployed as Docker images	Part of specification	Medium
COM-52	The COMPOSITION Marketplace Management System shall enable stakeholders to visualize existing public, closed markets	Part of specification	Major
COM-50	The COMPOSITION Marketplace Management System shall enable stakeholder to gain access to the COMPOSITION open marketplace	Part of specification	Major
COM-3	COMPOSITION Marketplace(s) should have possibility of restricted access	Part of specification	Major

5.4.2 Advanced Human Machine Interfaces

The 49 requirements listed in Table 12 are associated with this component.

Table 12: Requirements for Advanced HMIs

Key	Summary	Status	Priority
COM-150	The HMI shall enable Technician to view and search for past equipment issues	Open	Medium
COM-147	ELDIA provides criteria for truck selection	Open	Major
COM-146	The system shall allow the user to provide specifications for bidders for scrap metal	Quality Check passed	Major
COM-145	The system shall enable to stop production	Quality Check passed	Nice to have
COM-144	The line visualization shall compare the actual processed units to the target ones	Quality Check passed	Minor
COM-142	The system shall know how many assets can be processed by machine and by time	Quality Check passed	Minor
COM-139	All components with a public endpoint shall enforce authentication and authorization	Open	Major
COM-135	The system shall visualize the state of all equipment on one screen: up or down	Open	Medium
COM-133	The location of a reel or tray shall be visualized on a map with area names on it	Open	Medium
COM-132	Reels and Trays shall be found by KANBAN and part number input	Open	Medium
COM-131	Comments and updates can be added to the equipment Downtime log	Open	Minor
COM-130	Equipment issues can be reported manually	Open	Minor
COM-129	System shall assist Technician in solving equipment issues	Open	Medium
COM-128	Reminders for equipment resolution are issued	Open	Minor
COM-127	Alarms/Notifications are forwarded to subscribers depending on their impact level	Open	Minor
COM-125	Equipment Monitoring Screen is able to display predictive maintenance information for the machines where it is available	Open	Medium
COM-124	Users on the big visualisation screen are logged out automatically after defined time period and the view returns to the public overview screen	Open	Medium
COM-121	A downtime log should be available for each equipment	Open	Medium
COM-119	Persons with a viable login can define their equipment subscriptions	Open	Minor
COM-118	System should allow only logged in users to create, edit and view comments related to downtime log	Quality Check passed	Medium
COM-117	Details about equipment can be accessed when equipment is selected on overview screen	Open	Minor
COM-116	The equipment monitoring overview screen is able to show the	Open	Medium

Key	Summary	Status	Priority
	flow of the product (PCBAs) through the lines in real time		
COM-115	The equipment monitoring overview screen is able to show the relevant information on the equipment in real time	Open	Minor
COM-114	Equipment representation in IIMS can be adapted to line moves	Open	Minor
COM-113	The IIMS shall automatically send an NC report to a pre-defined list of recipients	Part of specification	Medium
COM-112	The system shall visualize idle machines in KLE's production process	Part of specification	Medium
COM-108	The system shall integrate all IIMS and Marketplace HMIs in one application	Quality Check passed	Major
COM-102	The Non-Conformance Dashboard shall display NCs for each Production Unit	Part of specification	Medium
COM-101	It must be possible to reset an alert when the necessary measures have been taken	Part of specification	Major
COM-99	An alert shall be displayed if the status of equipment or production unit changes	Part of specification	Major
COM-98	Time-to-failure limits for the measured parameters can be manually defined for the equipment in the production units	Part of specification	Major
COM-97	Visualization screen shall display status of machines in the production line	Part of specification	Major
COM-64	The system provides an automatic ranking of the suppliers to the buyers, based on customers' satisfaction and feedback	Part of specification	Nice to have
COM-57	The contractor shall be able to create offers in the IIMS system	Part of specification	Minor
COM-55	The contractor shall inform the IIMS when the collection of a metal scrap container is completed	Part of specification	Major
COM-53	The Maintenance Manager shall receive information that the scrap metal container is full	Part of specification	Major
COM-52	The COMPOSITION Marketplace Management System shall enable stakeholders to visualize existing public, closed markets	Part of specification	Major
COM-51	The COMPOSITION Marketplace Management System shall enable stakeholders to define closed marketplaces	Part of specification	Major
COM-50	The COMPOSITION Marketplace Management System shall enable stakeholder to gain access to the COMPOSITION open marketplace	Part of specification	Major
COM-34	Time frames for data pulls shall be freely configurable (BSL)	Quality Check passed	Major
COM-33	Items from BSL's inventory shall be requested automatically	Quality Check passed	Medium
COM-28	BSL's production data shall be observable in real time per machine	Open	Major
COM-26	Batches shall be identifiable in BSL's production line	Quality Check passed	Medium
COM-25	Items shall be trackable also when not located in BSL's production lines	Quality Check passed	Medium
COM-13	Optimal routes for collecting bin shall be recommended to KLE's worker	Part of specification	Minor
COM-12	The system shall simulate production processes	Part of specification	Major
COM-8	On request, information on fill level of the metal scrap container shall be provided	Open	Major
COM-7	The employee shall be informed in which metal scrap container to dispose of the bin content	Quality Check passed	Major
COM-6	The employee shall be informed when a metal scrap bin is full	Part of specification	Major

5.4.3 Authentication

The 10 requirements listed in Table 13 are associated with this component.

Table 13: Requirements for Authentication

Key	Summary	Status	Priority
COM-147	ELDIA provides criteria for truck selection	Open	Major
COM-146	The system shall allow the user to provide specifications for bidders for scrap metal	Quality Check passed	Major
COM-119	Persons with a viable login can define their equipment subscriptions	Open	Minor
COM-90	Ecosystem components should be deployed as Docker images	Part of specification	Medium
COM-66	Products/services offered via the ecosystem are COMPOSITION compatible	Open	Medium
COM-64	The system provides an automatic ranking of the suppliers to the buyers, based on customers' satisfaction and feedback	Part of specification	Nice to have
COM-61	Suppliers' product/services shall be matched with a potential customer's needs/problems	Part of specification	Major
COM-51	The COMPOSITION Marketplace Management System shall enable stakeholders to define closed marketplaces	Part of specification	Major
COM-50	The COMPOSITION Marketplace Management System shall enable stakeholder to gain access to the COMPOSITION open marketplace	Part of specification	Major
COM-3	COMPOSITION Marketplace(s) should have possibility of restricted access	Part of specification	Major

5.4.4 Big Data Analytics

The 12 requirements listed in Table 14 are associated with this component.

Table 14 Requirements for Big Data Analytics

Key	Summary	Status	Priority
COM-141	The COMPOSITION team shall define the limits of fan noise, RPM and power consumption, which define when an alarm is raised	Open	Major
COM-140	Fan alarms shall be raised if RPM, power consumption and noise of the fan exceed their limits	Open	Major
COM-139	All components with a public endpoint shall enforce authentication and authorization	Open	Major
COM-83	Zooming functionality shall be supported by the visual analytics module	Part of specification	Major
COM-82	Visualization presented to the user shall be synchronized	Quality Check passed	Major
COM-81	The visual analytics module shall import data coming from the simulation and prediction engine	Part of specification	Major
COM-72	The simulation and prediction engine shall import process models and Digital Factory models	Part of specification	Major
COM-70	Simulation data shall be exported for being visualized and explored	Part of specification	Major
COM-28	BSL's production data shall be observable in real time per machine	Open	Major
COM-27	Provide enough data for training artificial neural networks	Part of specification	Blocker
COM-20	The system shall detect patterns in data, without the need to explicitly search for them	Quality Check passed	Major
COM-4	Maintenance Data about machines shall be continuously collected	Part of specification	

5.4.5 Blockchain Connector

The 15 requirements listed in Table 15 are associated with this component.

Table 15: Requirements for Blockchain Connector

Key	Summary	Status	Priority
COM-90	Ecosystem components should be deployed as Docker images	Part of specification	Medium
COM-51	The COMPOSITION Marketplace Management System shall enable stakeholders to define closed marketplaces	Part of specification	Major
COM-49	Agents may be part of an organization or group of agents	Part of specification	Major
COM-48	Agents shall be individually addressable	Part of specification	Major
COM-47	Agent Communication Language shall have a standard and well-defined semantics	Part of specification	Major
COM-46	Agent Communication Language shall be based on messages	Part of specification	Major
COM-45	Agent Communication Language shall be agnostic to transport	Part of specification	Major
COM-44	Agents shall be writable in any programming language	Part of specification	Major
COM-42	AMS shall gracefully scale	Part of specification	Major
COM-41	AMS and DF shall be provided at the container (marketplace) level	Part of specification	Major
COM-37	Redundancy shall be kept as low as possible	Part of specification	Major
COM-36	Agent containers shall be natively distributed	Part of specification	Major
COM-18	Data transactions shall be immutable	Part of specification	Major
COM-17	Data transactions shall be traceable	Part of specification	Major
COM-3	COMPOSITION Marketplace(s) should have possibility of restricted access	Part of specification	Major

5.4.6 Building Management System

One requirement, listed in Table 16, is associated with this component.

Table 16: Requirement for BMS

Key	Summary	Status	Priority
COM-151	System shall allow recording and searching of equipment issues	Open	Medium

5.4.7 Data Collection System

The 16 requirements listed in Table 17 are associated with this component.

Table 17: Requirements for Data Collection System

Key	Summary	Status	Priority
COM-147	ELDIA provides criteria for truck selection	Open	Major
COM-146	The system shall allow the user to provide specifications for bidders for scrap metal	Quality Check passed	Major
COM-145	The system shall enable to stop production	Quality Check passed	Nice to have

Key	Summary	Status	Priority
COM-143	The system shall know how many assets are currently processed by machine	Open	Minor
COM-138	Where possible asset tags should be self-powered	Open	Medium
COM-137	Asset must have a wireless tag that wakes up and reports when moved or triggered	Open	Medium
COM-135	The system shall visualize the state of all equipment on one screen: up or down	Open	Medium
COM-134	The material location sensor needs to be connected to a KANBAN and part number	Open	Medium
COM-123	To resolve an equipment issue a given set of conditions must be met	Quality Check passed	Medium
COM-122	Equipment status changes automatically based on light tower and alarm information	Open	Medium
COM-53	The Maintenance Manager shall receive information that the scrap metal container is full	Part of specification	Major
COM-26	Batches shall be identifiable in BSL's production line	Quality Check passed	Medium
COM-25	Items shall be trackable also when not located in BSL's production lines	Quality Check passed	Medium
COM-8	On request, information on fill level of the metal scrap container shall be provided	Open	Major
COM-4	Maintenance Data about machines shall be continuously collected	Part of specification	Major
COM-1	The fill level of metal scrap containers shall be monitored	Part of specification	Major

5.4.8 Deep Learning Toolkit

The 10 requirements listed in Table 18 are associated with this component.

Table 18: Requirements for Deep Learning Toolkit

Key	Summary	Status	Priority
COM-147	ELDIA provides criteria for truck selection	Open	Major
COM-141	The COMPOSITION team shall define the limits of fan noise, RPM and power consumption, which define when an alarm is raised	Open	Major
COM-140	Fan alarms shall be raised if RPM, power consumption and noise of the fan exceed their limits	Open	Major
COM-65	The ranking component includes a machine learning system to continuously improve the recommendations it gives out	Part of specification	Nice to have
COM-32	Data output format of Deep Learning Toolkit should be homogenized	Part of specification	Minor
COM-31	Data input format of Deep Learning Toolkit should be homogenized	Part of specification	Major
COM-30	Data classification report latency	Part of specification	Medium
COM-27	Provide enough data for training artificial neural networks	Part of specification	Blocker
COM-20	The system shall detect patterns in data, without the need to explicitly search for them	Quality Check passed	Major
COM-9	The system shall suggest to maintain machines before they break	Part of specification	Major

5.4.9 Intrafactory Interoperability Layer

The 27 requirements listed in Table 19 are associated with this component.

Table 19: Requirements for IIL

Key	Summary	Status	Priority
COM-151	System shall allow recording and searching of equipment issues	Open	Medium
COM-145	The system shall enable to stop production	Quality Check passed	Nice to have
COM-131	Comments and updates can be added to the equipment Downtime log	Open	Minor
COM-130	Equipment issues can be reported manually	Open	Minor
COM-129	System shall assist Technician in solving equipment issues	Open	Medium
COM-128	Reminders for equipment resolution are issued	Open	Minor
COM-127	Alarms/Notifications are forwarded to subscribers depending on their impact level	Open	Minor
COM-125	Equipment Monitoring Screen is able to display predictive maintenance information for the machines where it is available	Open	Medium
COM-122	Equipment status changes automatically based on light tower and alarm information	Open	Medium
COM-120	Notifications are sent to technicians phones when they are on shift	Open	Medium
COM-116	The equipment monitoring overview screen is able to show the flow of the product (PCBAs) through the lines in real time	Open	Medium
COM-115	The equipment monitoring overview screen is able to show the relevant information on the equipment in real time	Open	Minor
COM-113	The IIMS shall automatically send an NC report to a pre-defined list of recipients	Part of specification	Medium
COM-112	The system shall visualize idle machines in KLE's production process	Part of specification	Medium
COM-97	Visualization screen shall display status of machines in the production line	Part of specification	Major
COM-53	The Maintenance Manager shall receive information that the scrap metal container is full	Part of specification	Major
COM-34	Time frames for data pulls shall be freely configurable (BSL)	Quality Check passed	Major
COM-33	Items from BSL's inventory shall be requested automatically	Quality Check passed	Medium
COM-30	Data classification report latency	Part of specification	Medium
COM-28	BSL's production data shall be observable in real time per machine	Open	Major
COM-26	Batches shall be identifiable in BSL's production line	Quality Check passed	Medium
COM-25	Items shall be trackable also when not located in BSL's production lines	Quality Check passed	Medium
COM-21	The IIMS shall integrate different heterogeneous data sources	Quality Check passed	Major
COM-8	On request, information on fill level of the metal scrap container shall be provided	Open	Major
COM-6	The employee shall be informed when a metal scrap bin is full	Part of specification	Major
COM-4	Maintenance Data about machines shall be continuously collected	Part of specification	Major
COM-1	The fill level of metal scrap containers shall be monitored	Part of specification	Major

5.4.10 Manufacturing Big Data Storage

The 12 requirements listed in Table 20 are associated with this component.

Table 20: Requirements for Big Data Storage

Key	Summary	Status	Priority
COM-121	A downtime log should be available for each equipment	Open	Medium
COM-103	The IIMS shall be able to store and retrieve photos of NCs	Quality Check passed	Medium
COM-81	The visual analytics module shall import data coming from the simulation and prediction engine	Part of specification	Major
COM-78	The Decision Support System shall import data coming from the simulation and prediction engine	Part of specification	Major
COM-74	The simulation and prediction engine shall use historical data about production processes	Implemented	Major
COM-72	The simulation and prediction engine shall import process models and Digital Factory models	Part of specification	Major
COM-70	Simulation data shall be exported for being visualized and explored	Part of specification	Major
COM-34	Time frames for data pulls shall be freely configurable (BSL)	Quality Check passed	Major
COM-33	Items from BSL's inventory shall be requested automatically	Quality Check passed	Medium
COM-26	Batches shall be identifiable in BSL's production line	Quality Check passed	Medium
COM-25	Items shall be trackable also when not located in BSL's production lines	Quality Check passed	Medium
COM-20	The system shall detect patterns in data, without the need to explicitly search for them	Quality Check passed	Major

5.4.11 Manufacturing Decision Support System

The 27 requirements listed in Table 21 are associated with this component.

Table 21: Requirements for DSS

Key	Summary	Status	Priority
COM-143	The system shall know how many assets are currently processed by machine	Open	Minor
COM-139	All components with a public endpoint shall enforce authentication and authorization	Open	Major
COM-123	To resolve an equipment issue a given set of conditions must be met	Quality Check passed	Medium
COM-112	The system shall visualize idle machines in KLE's production process	Part of specification	Medium
COM-103	The IIMS shall be able to store and retrieve photos of NCs	Quality Check passed	Medium
COM-102	The Non-Conformance Dashboard shall display NCs for each Production Unit	Part of specification	Medium
COM-101	It must be possible to reset an alert when the necessary measures have been taken	Part of specification	Major
COM-100	Alerts shall be sent by email or SMS to predefined actors/roles	Part of specification	Major
COM-99	An alert shall be displayed if the status of equipment or production unit changes	Part of specification	Major
COM-98	Time-to-failure limits for the measured parameters can be manually defined for the equipment in the production units	Part of specification	Major
COM-97	Visualization screen shall display status of machines in the production line	Part of specification	Major

Key	Summary	Status	Priority
COM-96	The IIMS system automatically advises the contractor of the time for scrap metal pick-up	Part of specification	Major
COM-95	DSS will analyse events, suggestions and measures	Implemented	Major
COM-93	DSS will communicate/exchange the data	Implemented	Major
COM-92	Production of Simulated Data derived from Hypothetical Scenarios based on Current Trends	Part of specification	Major
COM-79	The Decision Support System shall receive data via web-services and they shall be processed in real time	Part of specification	Major
COM-78	The Decision Support System shall import data coming from the simulation and prediction engine	Part of specification	Major
COM-70	Simulation data shall be exported for being visualized and explored	Part of specification	Major
COM-56	The IIMS system automatically informs the contractor the fill level of the metal scrap containers	Part of specification	Major
COM-55	The contractor shall inform the IIMS when the collection of a metal scrap container is completed	Part of specification	Major
COM-53	The Maintenance Manager shall receive information that the scrap metal container is full	Part of specification	Major
COM-13	Optimal routes for collecting bin shall be recommended to KLE's worker	Part of specification	Minor
COM-12	The system shall simulate production processes	Part of specification	Major
COM-9	The system shall suggest to maintain machines before they break	Part of specification	Major
COM-8	On request, information on fill level of the metal scrap container shall be provided	Open	Major
COM-7	The employee shall be informed in which metal scrap container to dispose of the bin content	Quality Check passed	Major
COM-6	The employee shall be informed when a metal scrap bin is full	Part of specification	Major

5.4.12 Market Event Broker

The 16 requirements listed in Table 22 are associated with this component.

Table 22: Requirements for Market Event Broker

Key	Summary	Status	Priority
COM-139	All components with a public endpoint shall enforce authentication and authorization	Open	Major
COM-90	Ecosystem components should be deployed as Docker images	Part of specification	Medium
COM-59	Supplying companies register their products/services in specific topic(s) within the ecosystem	Part of specification	Major
COM-58	The needs and requirements of companies shall be registered/published within the ecosystem	Part of specification	Major
COM-51	The COMPOSITION Marketplace Management System shall enable stakeholders to define closed marketplaces	Part of specification	Major
COM-50	The COMPOSITION Marketplace Management System shall enable stakeholder to gain access to the COMPOSITION open marketplace	Part of specification	Major
COM-43	Message transport shall support several transport protocols	Part of specification	Major
COM-42	AMS shall gracefully scale	Part of specification	Major
COM-41	AMS and DF shall be provided at the container (marketplace) level	Part of specification	Major

Key	Summary	Status	Priority
COM-40	Message transport shall support authentication / encryption / access control	Part of specification	Major
COM-39	Message transport shall be general purpose	Part of specification	Major
COM-38	Message transport shall be scalable	Part of specification	Major
COM-37	Redundancy shall be kept as low as possible	Part of specification	Major
COM-36	Agent containers shall be natively distributed	Part of specification	Major
COM-35	Agents must not be forced to run in a single, pre-defined location	Part of specification	Major
COM-3	COMPOSITION Marketplace(s) should have possibility of restricted access	Part of specification	Major

5.4.13 Marketplace

The 12 requirements listed in Table 23 are associated with this component.

Table 23: Requirements for Marketplace

Key	Summary	Status	Priority
COM-148	Matchmaker and Agents components should be able to access and manipulate Marketplace Ontology	Part of specification	Medium
COM-146	The system shall allow the user to provide specifications for bidders for scrap metal	Quality Check passed	Major
COM-91	Supplying companies advertise their products/services in specific topic(s) within the ecosystem	Part of specification	Nice to have
COM-90	Ecosystem components should be deployed as Docker images	Part of specification	Medium
COM-63	The system provides an automatic ranking of the suppliers to the buyers, based on the buyers' criteria	Part of specification	Major
COM-58	The needs and requirements of companies shall be registered/published within the ecosystem	Part of specification	Major
COM-57	The contractor shall be able to create offers in the IIMS system	Part of specification	Minor
COM-55	The contractor shall inform the IIMS when the collection of a metal scrap container is completed	Part of specification	Major
COM-53	The Maintenance Manager shall receive information that the scrap metal container is full	Part of specification	Major
COM-51	The COMPOSITION Marketplace Management System shall enable stakeholders to define closed marketplaces	Part of specification	Major
COM-50	The COMPOSITION Marketplace Management System shall enable stakeholder to gain access to the COMPOSITION open marketplace	Part of specification	Major
COM-49	Agents may be part of an organization or group of agents	Part of specification	Medium

5.4.14 Marketplace UI

The 11 requirements listed in Table 24 are associated with this component.

Table 24: Requirements for Marketplace UI

Key	Summary	Status	Priority
COM-146	The system shall allow the user to provide specifications for bidders for scrap metal	Quality Check passed	Major
COM-139	All components with a public endpoint shall enforce authentication	Open	Major

	and authorization		
COM-108	The system shall integrate all IIMS and Marketplace HMIs in one application	Quality Check passed	Major
COM-90	Ecosystem components should be deployed as Docker images	Part of specification	Medium
COM-57	The contractor shall be able to create offers in the IIMS system	Part of specification	Minor
COM-55	The contractor shall inform the IIMS when the collection of a metal scrap container is completed	Part of specification	Major
COM-53	The Maintenance Manager shall receive information that the scrap metal container is full	Part of specification	Major
COM-52	The COMPOSITION Marketplace Management System shall enable stakeholders to visualize existing public, closed markets	Part of specification	Major
COM-51	The COMPOSITION Marketplace Management System shall enable stakeholders to define closed marketplaces	Part of specification	Major
COM-50	The COMPOSITION Marketplace Management System shall enable stakeholder to gain access to the COMPOSITION open marketplace	Part of specification	Major
COM-49	Agents may be part of an organization or group of agents	Part of specification	Major

5.4.15 MatchMaker

The 21 requirements listed in Table 25 are associated with this component.

Table 25: Requirements for MatchMaker

Key	Summary	Status	Priority
COM-148	Matchmaker and Agents components should be able to access and manipulate Marketplace Ontology	Part of specification	Medium
COM-90	Ecosystem components should be deployed as Docker images	Part of specification	Medium
COM-89	Matchmaker shall return a result within a reasonable time frame	Part of specification	Major
COM-88	Different decision criteria for supplier selection are supported by the Matchmaker	Implemented	Major
COM-87	Different similarity algorithms and metrics shall be supported by the Matchmaker	Part of specification	Major
COM-86	The Matchmaker shall apply both syntactic and semantic matching	Part of specification	Major
COM-64	The system provides an automatic ranking of the suppliers to the buyers, based on customers' satisfaction and feedback	Part of specification	Nice to have
COM-63	The system provides an automatic ranking of the suppliers to the buyers, based on the buyers' criteria	Part of specification	Major
COM-61	Suppliers' product/services shall be matched with a potential customers' needs/problems	Part of specification	Major
COM-51	The COMPOSITION Marketplace Management System shall enable stakeholders to define closed marketplaces	Part of specification	Major
COM-50	The COMPOSITION Marketplace Management System shall enable stakeholder to gain access to the COMPOSITION open marketplace	Part of specification	Major
COM-49	Agents may be part of an organization or group of agents	Part of specification	Major
COM-48	Agents shall be individually addressable	Part of specification	Major
COM-47	Agent Communication Language shall have a standard and well-defined semantics	Part of specification	Major
COM-46	Agent Communication Language shall be based on messages	Part of	Major

Key	Summary	Status	Priority
		specification	
COM-45	Agent Communication Language shall be agnostic to transport	Part of specification	Major
COM-44	Agents shall be writable in any programming language	Part of specification	Major
COM-42	AMS shall gracefully scale	Part of specification	Major
COM-41	AMS and DF shall be provided at the container (marketplace) level	Part of specification	Major
COM-37	Redundancy shall be kept as low as possible	Part of specification	Major
COM-36	Agent containers shall be natively distributed	Part of specification	Major

5.4.16 Modelling

The 7 requirements listed in Table 26 are associated with this component.

Table 26: Requirements for Modelling

Key	Summary	Status	Priority
COM-149	COMPOSITION sensors' data should be described in a common format	Quality Check passed	Medium
COM-114	Equipment representation in IIMS can be adapted to line moves	Open	Minor
COM-69	COMPOSITION DFM has to be multi-scaled	Implemented	Major
COM-68	Ontologies shall be implemented in OWL language	Implemented	Major
COM-67	Business processes must be described using the BPMN standard	Part of specification	Major
COM-15	The processes and stakeholders of the pilots shall be modelled	Part of specification	Major
COM-14	A common methodology and notation for modelling shall be established	Implemented	Major

5.4.17 Ontology

The 6 requirements listed in Table 27 are associated with this component.

Table 27: Requirements for Ontology

Key	Summary	Status	Priority
COM-148	Matchmaker and Agents components should be able to access and manipulate Marketplace Ontology	Part of specification	Medium
COM-85	Service ontology has to describe manufacturing service capabilities in different levels of abstraction (e.g. process level, machine level, shop level and supplier level)	Implemented	Major
COM-68	Ontologies shall be implemented in OWL language	Implemented	Major
COM-59	Supplying companies register their products/services in specific topic(s) within the ecosystem	Part of specification	Major
COM-58	The needs and requirements of companies shall be registered/published within the ecosystem	Part of specification	Major
COM-50	The COMPOSITION Marketplace Management System shall enable stakeholder to gain access to the COMPOSITION open marketplace	Part of specification	Major

5.4.18 Real Time Multi-Protocol Event Broker

The requirement listed in Table 28 is associated with this component.

Table 28: Requirements for RT MP Event Broker

Key	Summary	Status	Priority
COM-139	All components with a public endpoint shall enforce authentication and authorization	Open	Major

5.4.19 Requestor Agent

The 20 requirements listed in Table 29 are associated with this component.

Table 29: Requirements for Requestor Agent

Key	Summary	Status	Priority
COM-146	The system shall allow the user to provide specifications for bidders for scrap metal	Quality Check passed	Major
COM-139	All components with a public endpoint shall enforce authentication and authorization	Open	Major
COM-91	Supplying companies advertise their products/services in specific topic(s) within the ecosystem	Part of specification	Nice to have
COM-90	Ecosystem components should be deployed as Docker images	Part of specification	Medium
COM-59	Supplying companies register their products/services in specific topic(s) within the ecosystem	Part of specification	Major
COM-58	The needs and requirements of companies shall be registered/published within the ecosystem	Part of specification	Major
COM-57	The contractor shall be able to create offers in the IIMS system	Part of specification	Minor
COM-51	The COMPOSITION Marketplace Management System shall enable stakeholders to define closed marketplaces	Part of specification	Major
COM-49	Agents may be part of an organization or group of agents	Part of specification	Major
COM-48	Agents shall be individually addressable	Part of specification	Major
COM-47	Agent Communication Language shall have a standard and well defined semantics	Part of specification	Major
COM-46	Agent Communication Language shall be based on messages	Part of specification	Major
COM-45	Agent Communication Language shall be agnostic to transport	Part of specification	Major
COM-44	Agents shall be writable in any programming language	Part of specification	Major
COM-42	AMS shall gracefully scale	Part of specification	Major
COM-41	AMS and DF shall be provided at the container (marketplace) level	Part of specification	Major
COM-37	Redundancy shall be kept as low as possible	Part of specification	Major
COM-36	Agent containers shall be natively distributed	Part of specification	Major
COM-35	Agents must not be forced to run in a single, pre-defined location	Part of specification	Major
COM-3	COMPOSITION Marketplace(s) should have possibility of restricted access	Part of specification	Major

5.4.20 Security Information and Event Management

The 5 requirements listed in Table 30 are associated with this component.

Table 30: Requirements for Security Information and Event Management

Key	Summary	Status	Priority
COM-90	Ecosystem components should be deployed as Docker images	Part of specification	Medium
COM-19	The system shall be protected against cyber attacks	Part of specification	Major
COM-18	Data transactions shall be immutable	Part of specification	Major
COM-17	Data transactions shall be traceable	Part of specification	Major
COM-16	Only a specific group of receivers shall have access to data	Part of specification	Major

5.4.21 Service Catalog

Presently no requirements are associated with this component.

5.4.22 Simulation and Forecasting Tool

The 22 requirements listed in Table 31 are associated with this component.

Table 31: Requirements for Simulation and Forecasting Tool

Key	Summary	Status	Priority
COM-112	The system shall visualize idle machines in KLE's production process	Part of specification	Medium
COM-101	It must be possible to reset an alert when the necessary measures have been taken	Part of specification	Major
COM-100	Alerts shall be sent by email or SMS to predefined actors/roles	Part of specification	Major
COM-99	An alert shall be displayed if the status of equipment or production unit changes	Part of specification	Major
COM-98	Time-to-failure limits for the measured parameters can be manually defined for the equipment in the production units	Part of specification	Major
COM-97	Visualization screen shall display status of machines in the production line	Part of specification	Major
COM-96	The IIMS system automatically advises the contractor of the time for scrap metal pick-up	Part of specification	Major
COM-92	Production of Simulated Data derived from Hypothetical Scenarios based on Current Trends	Part of specification	Major
COM-81	The visual analytics module shall import data coming from the simulation and prediction engine	Part of specification	Major
COM-78	The Decision Support System shall import data coming from the simulation and prediction engine	Part of specification	Major
COM-77	The simulation and prediction engine shall apply machine learning techniques on production line's historical data	Part of specification	Major
COM-76	Simulation tool shall be able to simulate and display production line assets and equipment as they represented in DFM	Part of specification	Major
COM-74	The simulation and prediction engine shall use historical data about production processes	Implemented	Major
COM-73	The simulation and prediction engine shall use data coming from sensors	Part of specification	Major
COM-72	The simulation and prediction engine shall import process models and Digital Factory models	Part of specification	Major
COM-71	Simulation shall support also hypothetical scenarios for both production and logistics chains	Part of specification	Major

Key	Summary	Status	Priority
COM-70	Simulation data shall be exported for being visualized and explored	Part of specification	Major
COM-56	The IIMS system automatically informs the contractor the fill level of the metal scrap containers	Part of specification	Major
COM-12	The system shall simulate production processes	Part of specification	Major
COM-9	The system shall suggest to maintain machines before they break	Part of specification	Major
COM-4	Maintenance Data about machines shall be continuously collected	Part of specification	Major
COM-2	The IIMS shall be able to forecast when the container is full	Part of specification	Major

5.4.23 Supplier Agent

The 17 requirements listed in Table 32 are associated with this component.

Table 32: Requirements for Supplier Agent

Key	Summary	Status	Priority
COM-139	All components with a public endpoint shall enforce authentication and authorization	Open	Major
COM-90	Ecosystem components should be deployed as Docker images	Part of specification	Medium
COM-66	Products/services offered via the ecosystem are COMPOSITION compatible	Open	Medium
COM-57	The contractor shall be able to create offers in the IIMS system	Part of specification	Minor
COM-51	The COMPOSITION Marketplace Management System shall enable stakeholders to define closed marketplaces	Part of specification	Major
COM-49	Agents may be part of an organization or group of agents	Part of specification	Major
COM-48	Agents shall be individually addressable	Part of specification	Major
COM-47	Agent Communication Language shall have a standard and well defined semantics	Part of specification	Major
COM-46	Agent Communication Language shall be based on messages	Part of specification	Major
COM-45	Agent Communication Language shall be agnostic to transport	Part of specification	Major
COM-44	Agents shall be writable in any programming language	Part of specification	Major
COM-42	AMS shall gracefully scale	Part of specification	Major
COM-41	AMS and DF shall be provided at the container (marketplace) level	Part of specification	Major
COM-37	Redundancy shall be kept as low as possible	Part of specification	Major
COM-36	Agent containers shall be natively distributed	Part of specification	Major
COM-35	Agents must not be forced to run in a single, pre-defined location	Part of specification	Major
COM-3	COMPOSITION Marketplace(s) should have possibility of restricted access	Part of specification	Major

6 New Innovations in COMPOSITION

To ensure that the project has strong and continued focus on successful implementation of creative ideas, the COMPOSITION consortium has created a dedicated and strategic structure for managing the innovation activities. This process is described in *D2.2 Initial Requirements Specification* and further detailed in *D1.1 Project Quality Control Plan 1.*

In addition to the five initial Innovations reported in D2.2, three more Innovations been identified:

I-06 Deep Learning Toolkit

I-07 Process-Oriented Monitoring Framework

I-08 Big Data Analysis Service

The new Innovations have been added to the COMPOSITION Innovation project in the JIRA installation hosted by IN-JET.

A complete list of Innovations can be found in Appendix B.

7 Conclusion

This deliverable describes the requirements engineering work performed in the first half of the project by way of the iterative process adopted for the COMPOSITION project.

The COMPOSITION approach to Lessons Learned has been defined, and the Lessons Learned documented and analysed per Work Package. A total of 26 Lessons Learned has been collected and verified, and an overview of changes in the requirements compared to the list in *D2.2 Initial Requirements Specification* is provided.

The enhancements to the COMPOSITION architecture has resulted in the addition of five new Components to the proposed solution, and three additional Innovations have been identified.

As of mid-November 2017, the COMPOSITION JIRA repository contains 125 active requirements, 8 of which have been implemented, while 70 have status Part of Specification, 17 have passed QC check and 30 are Open.

A further update largely following the same procedure and format as the present document will be provided in *D2.6 Lessons Learned and Updated Requirements Report II*, which is due in M28 (December 2018).

8 List of Figures and Tables

8.1 Figures

8.2 Tables

Appendix A – Updated List of Requirements

Table 33: Full List of requirements for COMPOSITION

Key	Summary	Requirement Type	Priority	Status	WP
COM-151	System shall allow recording and searching of equipment issues	Functional	Medium	Open	WP5
COM-150	The HMI shall enable Technician to view and search for past equipment issues	Functional	Medium	Open	WP5
COM-149	COMPOSITION sensors' data should be described in a common format	Non-Functional -> usability	Medium	Quality Check passed	WP3
COM-148	Matchmaker and Agents components should be able to access and manipulate Marketplace Ontology	Functional	Medium	Part of specification	WP6
COM-147	ELDIA provides criteria for truck selection	Project Issue -> task	Major	Open	
COM-146	The system shall allow the user to provide specifications for bidders for scrap metal	Non-Functional -> operational	Major	Quality Check passed	
COM-145	The system shall enable to stop production	Functional	Nice to have	Quality Check passed	WP5
COM-144	The line visualization shall compare the actual processed units to the target ones	Functional	Minor	Quality Check passed	WP5
COM-143	The system shall know how many assets are currently processed by machine	Functional	Minor	Open	WP5
COM-142	The system shall know how many assets can be processed by machine and by time	Functional	Minor	Quality Check passed	WP5
COM-141	The COMPOSITION team shall define the limits of fan noise, RPM and power consumption, which define when an alarm is raised	Non-Functional	Major	Open	
COM-140	Fan alarms shall be raised if RPM, power consumption and noise of the fan exceed their limits	Functional	Major	Open	
COM-139	All components with a public endpoint shall enforce authentication and authorization	Non-Functional -> security	Major	Open	
COM-138	Where possible asset tags should be self-powered	Functional	Medium	Open	WP5
COM-137	Asset must have a wireless tag that wakes up and reports when moved or triggered	Functional	Medium	Open	WP5
COM-136	The system shall also visualize up or down status of equipment which is currently not visualized in BSL systems	Functional	Medium	Rejected	
COM-135	The system shall visualize the state of all equipment on one screen: up or down	Functional	Medium	Open	WP5
COM-134	The material location sensor needs to be connected to a KANBAN and part number	Functional	Medium	Open	WP5
COM-133	The location of a reel or tray shall be visualized on a map with area names on it	Functional	Medium	Open	WP5
COM-132	Reels and Trays shall be found by KANBAN and part number input	Functional	Medium	Open	WP5
COM-131	Comments and updates can be added to the equipment Downtime log	Functional	Minor	Open	WP5

Key	Summary	Requirement Type	Priority	Status	WP
COM-130	Equipment issues can be reported manually	Functional	Minor	Open	WP5
COM-129	System shall assist Technician in solving equipment issues	Functional	Medium	Quality Check passed	WP5
COM-128	Reminders for equipment resolution are issued	Functional	Minor	Open	WP5
COM-127	Alarms/Notifications are forwarded to subscribers depending on their impact level	Functional	Minor	Open	WP5
COM-126	IIMS is able to obtain relevant information from Asset Management System	Functional	Minor	Rejected	
COM-125	Equipment Monitoring Screen is able to display predictive maintenance information for the machines where it is available	Functional	Medium	Open	WP5
COM-124	Users on the big visualisation screen are logged out automatically after defined time period and the view returns to the public overview screen	Functional	Medium	Open	WP5
COM-123	To resolve an equipment issue a given set of conditions must be met	Functional	Medium	Quality Check passed	WP3
COM-122	Equipment status changes automatically based on light tower and alarm information	Functional	Medium	Open	WP5
COM-121	A downtime log should be available for each equipment	Functional	Medium	Open	WP5
COM-120	Notifications are sent to technicians phones when they are on shift	Functional	Medium	Open	
COM-119	Persons with a viable login can define their equipment subscriptions	Functional	Minor	Open	WP5
COM-118	System should allow only logged in users to create, edit and view comments related to downtime log	Functional	Medium	Quality Check passed	
COM-117	Details about equipment can be accessed when equipment is selected on overview screen	Functional	Minor	Open	WP5
COM-116	The equipment monitoring overview screen is able to show the flow of the product (PCBAs) through the lines in real time	Functional	Medium	Open	WP5
COM-115	The equipment monitoring overview screen is able to show the relevant information on the equipment in real time	Functional	Minor	Open	WP5
COM-114	Equipment representation in IIMS can be adapted to line moves	Functional	Minor	Open	WP3
COM-113	The IIMS shall automatically send an NC report to a pre-defined list of recipients	Functional	Medium	Rejected	
COM-112	The system shall visualize idle machines in KLE's production process	Functional	Medium	Part of specification	WP5
COM-111	The system shall provide an NC overview to the user	Functional	Medium	Rejected	
COM-110	The NC monitoring visualisation screen should offer filter options to the user	Functional	Medium	Rejected	
COM-108	The system shall integrate all IIMS and Marketplace HMIs in one application	Functional	Major	Quality Check passed	WP5
COM-107	The NC monitoring visualisation screen shall be operable from close range and far distance	Functional	Medium	Rejected	

Key	Summary	Requirement Type	Priority	Status	WP
COM-106	The NC visualisation screen shall be usable on different screen sizes	Functional	Medium	Rejected	
COM-105	The IIMS shall be able to generate alerts if the colour indication of a Production Unit changes to Red	Functional	Major	Rejected	
COM-104	The Non-Conformance Dashboard shall reflect the number of NCs as green, amber or red.	Non-Functional -> look and feel	Medium	Rejected	
COM-103	The IIMS shall be able to store and retrieve photos of NCs	Functional	Medium	Rejected	
COM-102	The Non-Conformance Dashboard shall display NCs for each Production Unit	Functional	Medium	Part of specification	
COM-101	It must be possible to reset an alert when the necessary measures have been taken	Functional	Major	Part of specification	WP5
COM-100	Alerts shall be sent by email or SMS to predefined actors/roles	Functional	Major	Part of specification	WP3
COM-99	An alert shall be displayed if the status of equipment or production unit changes	Functional	Major	Part of specification	WP5
COM-98	Time-to-failure limits for the measured parameters can be manually defined for the equipment in the production units	Functional	Major	Part of specification	WP5
COM-97	Visualization screen shall display status of machines in the production line	Functional	Major	Part of specification	WP5
COM-96	The IIMS system automatically advises the contractor of the time for scrap metal pick-up	Functional	Major	Part of specification	WP3
COM-95	DSS will analyse events, suggestions and measures	Functional	Major	Implemented	WP3
COM-94	Interfaces shall facilitate machine learning toolkit forecast	Non-Functional -> operational	Major	Rejected	
COM-93	DSS will communicate/exchange the data	Functional	Major	Implemented	WP3
COM-92	Production of Simulated Data derived from Hypothetical Scenarios based on Current Trends	Non-Functional -> operational	Major	Part of specification	WP3
COM-91	Supplying companies advertise their products/services in specific topic(s) within the ecosystem	Functional	Nice to have	Part of specification	WP6
COM-90	Ecosystem components should be deployed as Docker images	Non-Functional -> operational	Medium	Part of specification	WP6
COM-89	Matchmaker shall return a result within a reasonable time frame	Non-Functional -> performance	Major	Part of specification	WP6
COM-88	Different decision criteria for supplier selection are supported by the Matchmaker	Functional	Major	Implemented	WP6
COM-87	Different similarity algorithms and metrics shall be supported by the Matchmaker	Functional	Major	Part of specification	WP6

Key	Summary	Requirement Type	Priority	Status	WP
COM-86	The Matchmaker shall apply both syntactic and semantic matching	Functional	Major	Part of specification	WP6
COM-85	Service ontology has to describe manufacturing service capabilities in different levels of abstraction (e.g. process level, machine level, shop level and supplier level)	Functional	Major	Implemented	WP6
COM-84	COMPOSITION's IIMS shall be able to store and retrieve large amounts of data	Non-Functional -> operational	Major	Rejected	
COM-83	Zooming functionality shall be supported by the visual analytics module	Functional	Major	Part of specification	WP5
COM-82	Visualization presented to the user shall be synchronized	Functional	Major	Quality Check passed	WP5
COM-81	The visual analytics module shall import data coming from the simulation and prediction engine	Functional	Major	Part of specification	WP5
COM-80	COMPOSITION UIs shall be usable	Non-Functional -> usability	Major	Rejected	
COM-79	The Decision Support System shall receive data via web-services and they shall be processed in real time	Functional	Major	Part of specification	WP3
COM-78	The Decision Support System shall import data coming from the simulation and prediction engine	Functional	Major	Part of specification	WP3
COM-77	The simulation and prediction engine shall apply machine learning techniques on production line's historical data	Functional	Major	Part of specification	WP3
COM-76	Simulation tool shall be able to simulate and display production line assets and equipment as they represented in DFM	Functional	Major	Part of specification	WP3
COM-75	Sensors from production line shall provide data to the simulation and forecasting tool	Functional	Major	Rejected	
COM-74	The simulation and prediction engine shall use historical data about production processes	Functional	Major	Implemented	WP3
COM-73	The simulation and prediction engine shall use data coming from sensors	Functional	Major	Part of specification	WP3
COM-72	The simulation and prediction engine shall import process models and Digital Factory models	Functional	Major	Part of specification	WP3
COM-71	Simulation shall support also hypothetical scenarios for both production and logistics chains	Functional	Major	Part of specification	WP3
COM-70	Simulation data shall be exported for being visualized and explored	Functional	Major	Part of specification	WP5
COM-69	COMPOSITION DFM has to be multi-scaled	Non-Functional -	Major	Implemented	WP3

Key	Summary	Requirement Type	Priority	Status	WP
		> operational			
COM-68	Ontologies shall be implemented in OWL language	Non-Functional -> operational	Major	Implemented	WP6
COM-67	Business processes must be described using the BPMN standard	Non-Functional -> operational	Major	Part of specification	WP3
COM-66	Products/services offered via the ecosystem are COMPOSITION compatible	Non-Functional -> operational	Medium	Open	
COM-65	The ranking component includes a machine learning system to continuously improve the recommendations it gives ou	Non-Functional -> usability	Nice to have	Part of specification	WP5
COM-64	The system provides an automatic ranking of the suppliers to the buyers, based on customers' satisfaction and feedback	Functional	Nice to have	Part of specification	WP6
COM-63	The system provides an automatic ranking of the suppliers to the buyers, based on the buyers' criteria	Functional	Major	Part of specification	WP6
COM-62	All types of companies (buyers and suppliers) shall be subscribed to specific topics in the ecosystem according to their interests and needs	Functional	Medium	Rejected	
COM-61	Suppliers' product/services shall be matched with a potential customers' needs/problems	Non-Functional -> operational	Major	Part of specification	WP6
COM-60	Supplying companies register their products/services in specific topic(s) within the ecosystem	Non-Functional -> operational	Major	Rejected	
COM-59	Supplying companies register their products/services in specific topic(s) within the ecosystem	Non-Functional -> operational	Major	Part of specification	WP6
COM-58	The needs and requirements of companies shall be registered/published within the ecosystem	Non-Functional -> operational	Major	Part of specification	WP6
COM-57	The contractor shall be able to create offers in the IIMS system	Functional	Minor	Part of specification	WP6
COM-56	The IIMS system automatically informs the contractor the fill level of the metal scrap containers	Functional	Major	Part of specification	WP3
COM-55	The contractor shall inform the IIMS when the collection of a metal scrap container is completed	Functional	Major	Part of specification	WP2
COM-54	Purchasing Manager maintains the list of approved contractors	Functional	Major	Rejected	
COM-53	The Maintenance Manager shall receive information that the scrap metal container is full	Functional	Major	Part of specification	WP5
COM-52	The COMPOSITION Marketplace Management System shall enable stakeholders to visualize existing public, closed markets	Functional	Major	Part of specification	WP6
COM-51	The COMPOSITION Marketplace Management System shall enable stakeholders to define closed marketplaces	Functional	Major	Part of specification	WP6

Key	Summary	Requirement Type	Priority	Status	WP
COM-50	The COMPOSITION Marketplace Management System shall enable stakeholder to gain access to the COMPOSITION open marketplace	Functional	Major	Part of specification	WP6
COM-49	Agents may be part of an organization or group of agents	Functional	Major	Part of specification	WP6
COM-48	Agents shall be individually addressable	Functional	Major	Part of specification	WP6
COM-47	Agent Communication Language shall have a standard and well defined semantics	Non-Functional -> operational	Major	Part of specification	WP6
COM-46	Agent Communication Language shall be based on messages	Non-Functional -> operational	Major	Part of specification	WP6
COM-45	Agent Communication Language shall be agnostic to transport	Non-Functional -> operational	Major	Part of specification	WP6
COM-44	Agents shall be writable in any programming language	Non-Functional -> operational	Major	Part of specification	WP6
COM-43	Message transport shall support several transport protocols	Non-Functional -> operational	Major	Part of specification	WP6
COM-42	AMS shall gracefully scale	Non-Functional -> performance	Major	Part of specification	WP6
COM-41	AMS and DF shall be provided at the container (marketplace) level	Functional	Major	Part of specification	WP6
COM-40	Message transport shall support authentication / encryption / access control	Non-Functional -> operational	Major	Part of specification	WP6
COM-39	Message transport shall be general purpose	Non-Functional -> operational	Major	Part of specification	WP6
COM-38	Message transport shall be scalable	Non-Functional -> performance	Major	Part of specification	WP6
COM-37	Redundancy shall be kept as low as possible	Non-Functional -> operational	Major	Part of specification	WP6
COM-36	Agent containers shall be natively distributed	Non-Functional -> operational	Major	Part of specification	WP6
COM-35	Agents must not be forced to run in a single, pre-defined location	Non-Functional -> operational	Major	Part of specification	WP6
COM-34	Time frames for data pulls shall be freely configurable (BSL)	Non-Functional -> operational	Major	Quality Check passed	WP5
COM-33	Items from BSL's inventory shall be requested automatically	Non-Functional -> operational	Medium	Quality Check passed	WP5

Key	Summary	Requirement Type	Priority	Status	WP
COM-32	Data output format of Deep Learning Toolkit should be homogenized	Functional	Minor	Part of specification	WP5
COM-31	Data input format of Deep Learning Toolkit should be homogenized	Functional	Major	Part of specification	WP5
COM-30	Data classification report latency	Non-Functional -> operational	Medium	Part of specification	WP5
COM-29	Person in charge of the production process at BSL shall be contacted automatically if issues are detected	Functional	Major	Rejected	
COM-28	BSL's production data shall be observable in real time per machine	Functional	Major	Open	WP5
COM-27	Provide enough data for training artificial neural networks	Constraint -> assumption	Blocker	Part of specification	WP5
COM-26	Batches shall be identifiable in BSL's production line	Functional	Medium	Quality Check passed	WP5
COM-25	Items shall be trackable also when not located in BSL's production lines	Non-Functional -> operational	Medium	Quality Check passed	WP5
COM-24	Items on the line should be trackable in real time in BSL's production process	Non-Functional -> operational	Medium	Rejected	
COM-23	Documentation of non conformance (NC) should be done automatically in BSL's production process	Non-Functional -> operational	Major	Rejected	
COM-21	The IIMS shall integrate different heterogeneous data sources	Non-Functional -> operational	Major	Quality Check passed	WP5
COM-20	The system shall detect patterns in data, without the need to explicitly search for them	Functional	Major	Quality Check passed	WP5
COM-19	The system shall be protected against cyber attacks	Non-Functional -> security	Major	Part of specification	WP4
COM-18	Data transactions shall be immutable	Non-Functional -> security	Major	Part of specification	WP4
COM-17	Data transactions shall be traceable	Non-Functional -> security	Major	Part of specification	WP4
COM-16	Only a specific group of receivers shall have access to data	Non-Functional -> security	Major	Part of specification	WP4
COM-15	The processes and stakeholders of the pilots shall be modelled	Project Issue	Major	Part of specification	WP3
COM-14	A common methodology and notation for modelling shall be established	Project Issue	Major	Implemented	WP3

Key	Summary	Requirement Type	Priority	Status	WP
COM-13	Optimal routes for collecting bin shall be recommended to KLE's worker	Functional	Minor	Part of specification	WP3
COM-12	The system shall simulate production processes	Functional	Major	Part of specification	WP3
COM-11	The system shall visualize bottle necks in KLE's production process	Functional	Major	Rejected	
COM-10	The system shall monitor the status of KLE's polishing machine	Functional	Major	Rejected	
COM-9	The system shall suggest to maintain machines before they break	Functional	Major	Part of specification	WP3
COM-8	On request, information on fill level of the metal scrap container shall be provided	Functional	Major	Open	
COM-7	The employee shall be informed in which metal scrap container to dispose of the bin content	Functional	Major	Quality Check passed	WP3
COM-6	The employee shall be informed when a metal scrap bin is full	Functional	Major	Part of specification	WP5
COM-5	The offers for scrap metal shall be displayed for approval by the purchasing responsible	Functional	Major	Rejected	
COM-4	Maintenance Data about machines shall be continuously collected	Functional	Major	Part of specification	WP5
COM-3	COMPOSITION Marketplace(s) should have possibility of restricted access	Constraint -> stakeholders	Major	Part of specification	WP6
COM-2	The IIMS shall be able to forecast when the container is full	Functional	Major	Part of specification	WP3
COM-1	The fill level of metal scrap containers shall be monitored	Functional	Major	Part of specification	WP5

Appendix B – Innovations in COMPOSITION

This List contains all Innovations presently identified in COMPOSITION, including the new additions I-06, I-07 and I-08.

I-01 Supply Chain Blockchain

Description

The COMPOSITION architecture proposes to adapt and deploy a blockchain implementation as the central component of its log-oriented architecture. The log-oriented architecture will provide non-repudiation of transactions and distributed trust in the COMPOSITION marketplace for manufacturing and supply chains. In this context, the blockchain will be used to provide an audit trail for manufacturing and supply chain data, enabling both product data traceability and secure access for stakeholders. The blockchain shall be configurable for both public and consortium validation of blocks. Authentication in COMPOSITION marketplace shall be integrated with the blockchain.

Major functionalities

The following prioritised functionalities are enabled by the innovation:

Distributed trust in the agent marketplace

Decentralized log of agent transactions

Responsible WP

WP4

Innovation classification

Classify the innovation according to its dimensions:

Classification	Score
Fulfilment of the DOA	5
Demoability	3
Exploitability	4
Usefulness in pilot applications	3

Associated end user application requirements

List end user requirements for the COMPOSITION application that will be implemented using the innovation:

COM-17: Data transactions shall be traceable

COM-18: Data transactions shall be immutable

COM-19: The system shall be protected against cyber attacks

I-02 Matchmaking Broker

Description

The COMPOSITION Broker that will be responsible for connecting buyers and sellers of manufacturing services, raw materials and products towards building global supply chains. This will be achieved by applying both syntactic and semantic matching (both taxonomy-based and feature-based) in terms of manufacturing capabilities, in order to find the best possible supplier to fulfil a request for a service, raw materials or products involved in the supply chain. For measuring the similarity among offers and requests, well-established weighted similarity algorithms and metrics will be used and will be further extended if needed.

Different decision criteria for supplier selection according to several qualitative and quantitative factors will be considered (e.g. size of buyer's organization, cost, time, distance, due date, quality, price, technical capability, financial position, past performance, attitude, flexibility, etc.). The agent marketplace of COMPOSITION is not centralized as is the typical case. The Matchmaking Broker acts as a decentralized Directory Facilitator within the agent marketplace.

The Matchmaker offers the possibility to take into consideration matching by factors not known to the agents (buyer organization), e.g. externalities (environment, job markets, et c) in the choice of supplier selection.

Special focus will be given in dealing with the trade-off between performance and quality of matching, in order to provide responses in a reasonable time while at the same time minimization of computational complexities will be targeted.

Major functionalities

The following prioritised functionalities are enabled by the innovation:

Matching buyers and suppliers using types of information not known to the agents, e.g. environmental rating of suppliers or ratings/past performance supplied by other parties.

Responsible WP

WP6, The Process Modelling and Monitoring Framework developed in WP3 will be used as input.

Innovation classification

Classify the innovation according to its dimensions:

Classification	Score
Fulfilment of the DOA	5
Demoability	4
Exploitability	4
Usefulness in pilot applications	4

Associated end user application requirements

COM-64: The system provides an automatic ranking of the suppliers to the buyers, based on customers' satisfaction and feedback.

COM-86: The Matchmaker shall apply both syntactic and semantic matching

COM-87: Various similarity algorithms and metrics shall be supported by the Matchmaker

COM-88: Different decision criteria for supplier selection are supported by the Matchmaker

COM-89: Matchmaker shall return a result within 5 seconds

I-03 Manufacturing Decision Support System

Description

The Decision Support System (DSS) will combine information from the factory floor as well as from all stakeholders involved in the complete supply chain, interpreted by the semantic models produced in the COMPOSITION project. The aim of the DSS is to take a step forward towards a better understanding of the involved manufacturing processes and operations, the contribution of individual links of the supply chain, the effect of process monitoring in productivity, to facilitate communication and knowledge sharing among departments with different roles and responsibilities, the maintenance requirements and procedures and the detection of daily production details and flaws (ATL). Data will be processed combining big data analysis and deep learning. The data will be received using industry-standard web-services protocols (SOAP/REST) and formats (XML and JSON) and stored (if possible) in order to create an historical collection of data to be processed by the analysis tools. They will be coupled with the associated requests to certain parts of the supply chain, SOP (standard operating procedures) and response strategies, in order to offer feedback to the involved internal or external suppliers, in terms of actionable knowledge and recommendations, including maintenance operations and schedules.

Major functionalities

The following prioritised functionalities are enabled by the innovation:

Using the combination of several different technologies to visualize, analyse and forecast the performance of the factory and its supply chain.

Responsible WP

WP3

Innovation classification

Classify the innovation according to its dimensions:

Classification	Score
Fulfilment of the DOA	5
Demoability	5
Exploitability	4
Usefulness in pilot applications	5

Associated end user application requirements

COM-93 DSS will analyse data into a set of indicators and will provide a set of communications to other components

COM-92 Production of Simulated Data

COM-80 The UIs should be user-friendly

COM-79 The Decision Support System shall receive data via web-services and they shall be processed in real time

COM-78 The Decision Support System shall import data coming from the simulation and prediction engine

COM-70 Simulation data shall be exported for being visualized and explored

COM-56 The IIMS system automatically informs the contractor the fill level of the metal scrap containers

COM-55 The contractor shall inform the IIMS when the collection of a metal scrap container is completed

COM-23 Documentation of defective parts should be done automatically in BSL's production process

COM-13 Optimal routes for collecting bin shall be recommended to KLE's worker

COM-12 The system shall simulate KLE's production process

COM-9 The system shall suggest to maintain machines before they break

COM-8 On request, information on fill level of the metal scrap container shall be provided

COM-7 The employee shall be informed in which metal scrap container to dispose of the bin content

COM-6 The employee shall be informed when a metal scrap bin is full

COM-5 The offers for scrap metal shall be displayed for approval by the purchasing responsible

I-04 Dynamic Agent-based Marketplace

Description

Factories that are using the COMPOSITION system will be connected, creating a virtual market in support of the ecosystem of stakeholders. The dynamic agent-based marketplace enables the COMPOSITION ecosystem by an interoperable agent-based marketplace, where each party is represented by one or more agents, endowed with sufficient autonomy to set up exchanges and to enable new economic collaboration models.

The goal is to improve the process of establishing and tailoring supply chains to dynamically changing product lines and open new collaboration opportunities for every involved stakeholder. This is an autonomous and distributed approach which will enable more efficient operation of already existing, consortia of companies contributing to a single manufacturing process, but it will also open up possibilities for new partners to attain new business on the basis of a request / offer matching mechanism.

Major functionalities

The following prioritised functionalities are enabled by the innovation:

- *Open new business possibilities for external stakeholders, i.e. actors not yet part of a specified supply chain*
  - *Permits new partners to participate in existing supply chains*
- *Enables discovery of new stakeholders*
- *Stakeholders in existing supply chains can exchange services / data more effectively*
- *Collaboration and business interactions can be dynamically set up.*
- *Agents can autonomously perform transactions with other agents to optimise supply chains.*
  - *Automatic negotiation of terms of service for supply partners*
- *Provide a loosely coupled, decentralized agent marketplace where stakeholders are in control of their agent development and deployment.*

Responsible WP

WP6

Innovation classification

Classify the innovation according to its dimensions:

Classification	Score
Fulfilment of the DOA	5
Demoability	4
Exploitability	4
Usefulness in pilot applications	5

Associated end user application requirements

COM-91 Supplying companies advertise their products/services in specific topic(s) within the ecosystem.

COM-90 Ecosystem components should be deployed as Docker images.

COM-66 Products/services offered via the ecosystem are COMPOSITION compatible.

COM-62 All types of companies (buyers and suppliers) shall be subscribed to specific topics in the ecosystem according to their interests and needs

COM-59 Supplying companies register their products/services in specific topic(s) within the ecosystem.

COM-58 The needs and requirements of companies shall be registered/published within the ecosystem.

COM-52 The COMPOSITION Marketplace Management System shall enable stakeholders to visualize existing public, closed markets

COM-51 The COMPOSITION Marketplace Management System shall enable stakeholders to define close marketplaces

COM-50 The COMPOSITION Marketplace Management System shall enable stakeholder to gain access to the COMPOSITION open marketplace

COM-49 Agents might be part of an organization or group of agents

COM-48 Agents shall be individually addressable

COM-47 Agent Communication Language shall have a standard and well defined semantics

COM-46 Agent Communication Language shall be based on messages

COM-45 Agent Communication Language shall be agnostic to transport

COM-44 Agents shall be writable in any programming language

COM-42 AMS shall gracefully scale

COM-41 AMS and DF shall be provided at the container (marketplace) level

COM-37 Redundancy shall be kept as low as possible

COM-36 Agent containers shall be natively distributed

COM-35 Agents must not be forced to run in a single, pre-defined location

COM-33 Items from BSL's inventory shall be reordered automatically

COM-3 Ecosystem: multiple marketplaces; participation by invitation only

I-05 Incorporation of Prediction and Forecast into Decision Support Toolkit

Description

Hypothetical scenarios based on current trends will be used to help on manufacturing processes optimisation (simulation – based optimisation) and make the simulation engine ready to export simulation data according to monitoring framework specifications. Furthermore, indicators, events and suggestions will be provided to the individual links in the supply chain. Metrics about the monitoring process, as well as communication of the data, among departments with different roles and responsibilities, such as the maintenance requirements and procedures and the detection of daily production details and flaws will be given. Moreover, the developed interfaces shall facilitate the machine learning toolkit in forecast and predictions. They shall be designed easing the exported, from them, data to be exploitable in the machine learning process.

Major functionalities

The following prioritised functionalities are enabled by the innovation:

Combine data analytics and rule engine to create a set of indicators and prescribed actions. The data analysis will exploit the various sources of data and will elaborate the machine learning toolkit into an intelligent decision support system.

Create a simulation engine based on BPMN flow and simulated data to visualise different scenarios and what-if analysis.

Produce actionable data to other components, like events or notifications.

Responsible WP

WP3 – Manufacturing Modelling and Simulation

Innovation classification

Classify the innovation according to its dimensions:

Classification	Score
Fulfilment of the DOA	5
Demoability	4
Exploitability	4
Usefulness in pilot applications	5

Associated end user application requirements

COM-95: DSS will analyse events, suggestions and measures

COM-94: Interfaces shall facilitate machine learning toolkit forecast

COM-93: DSS will communicate/exchange the data

COM-92: Production of Simulated Data

I-06 COMPOSITION Deep Learning Toolkit

Description

The Deep Learning Toolkit is a component that belongs to the COMPOSITION ecosystem and has a twofold nature. The first aspect is the intra-factory scenario, in which it is involved in the decision-making process at the shop floor level, providing predictions leveraging on continuous learning algorithms. In order for this to

happen, it uses three offline phases: training, validation and testing, of historical data from the very same shop floor. The continuous learning phase happens online and is the one that is fully integrated with the intra-factory interoperability layer and the COMPOSITION ecosystem.

The second nature of the component belongs to the inter-factory scenario and it is based on providing predictions to the Agent-based marketplace. It provides a novel intelligence layer to the agent for trading in the most suitable conditions, providing knowledge of the market future status with punctual predictions based on the historical analysis of the trading historical data.

Major functionalities

In the intra-factory scenarios, it will provide predictions to decision system designated components at the shop floor level, leveraging on continuous learning Artificial Neural Networks.

In the inter-factory scenarios, it will provide predictions to the intelligence segment of the agent, in the Agent-based Marketplace, providing data analytics on transactions and profiling the behaviour of opponent agents using re-enforcement learning techniques.

Responsible WP

WP5

Innovation classification

Classification	Score
Fulfilment of the DOA	5
Demoability	4
Exploitability	4
Usefulness in pilot applications	5

Associated end user application requirements

- As main component in the requirement
  - COM-1
  - COM-4
  - COM-6
  - COM-7
  - COM-8
  - COM-20
  - COM-21
  - COM-27
  - COM-28
  - COM-30
  - COM-31
  - COM-32
  - COM-34
- Involved in the requirement

- COM-12
- COM-33
- COM-53
- COM-54
- COM-55
- COM-56
- COM-57
- COM-64
- COM-65
- COM-80
- COM-81
- COM-82
- COM-83
- COM-84

I-07 Process-Oriented Monitoring Framework

Description

The Process-Oriented Monitoring Framework will on one hand collect data from heterogeneous sensors available on shop floor, and on the other hand enrich data so that they are context-aware, which opens up more possibilities for later data processing. To achieve Process-Oriented Monitoring, sensor data will be first integrated onto a uniform data platform (e.g., LinkSmart IoT Platform) for easy access. Then the production process will be modelled with Business Process Model and Notation (BPMN), which is a graphical representation standard for specifying business processes in a business process model. During production runtime, an instance of the process model will be created to represent each product in the production line. This process instance will be managed by a BPMN engine, and it is synchronized with the real process with the help of sensor signals retrieved from the production line. In this way, sensor measurements can be annotated based on the active process activity as well as on a specific product. It enables investigation of production details such as performance in each production step as well as resources consumed for each product, etc. Furthermore, context-aware reactions to certain (unusual) events or combination of events will be possible.

Major functionalities

The following prioritised functionalities are enabled by the innovation:

Uniform data access, investigation of production details and context-aware reactions to certain (unusual) events or combination of events.

Responsible WP

WP3

Innovation classification

Classification	Score
Fulfilment of the DOA	5
Demoability	3
Exploitability	3
Usefulness in pilot applications	4

Associated end user application requirements

COM-10 The system shall monitor the status of KLE's polishing machine
COM-24 Items on the line should be trackable in real time in BSL's production process
COM-25 Items shall be trackable asides BSL's production line
COM-26 Batches shall be identifiable in BSL's production line
COM-28 BSL's production data shall be observable in real time per machine

I-08 Big Data Analysis Service

Description

Manufacturing in assembly lines consist in a set of hundreds, thousands or millions of small discrete steps aligned in a parallel production, management, maintenance and other kind of processes. Automatized production processes or production lines, they produce for each of those steps a small bits of data in form of events. The events possess valuable information, but this information loses the value through time. Additionally, the data in the events usually are meaningless if they are not contextualized, either by other events, sensor data or process context. To extract most value of the data, it must be process as it's produced. In other words, in real-time and on demand. Therefore, we prose for the Big Data Analysis Stream Mining driven that make use of Complex-Event Processing for the data management coming from the production facilities; and open it to embed analytic processes and algorithm. In this manner, the data is processed at the moment when is produced extracting the maximum value, reducing latency, providing reactivity, giving it context, and avoiding the need of archiving unnecessary data. In summary, The Big Data Analysis Service will enable set of applications or other services to enable their applications.

Major functionalities

The main functionalities provided by the Big Data Analysis Service are:

- Real-time Event Annotation
- Real-time Event Fusion
- Real-time Event Live Analysis
- Real-time Online Machine Learning Life Cycle Management
- Real-time Data Interoperability
- Real-time Data Endpoint and Protocol Routing

Responsible WP

WP5

Innovation classification

Classification	Score
Fulfilment of the DOA	5
Demoability	4
Exploitability	4
Usefulness in pilot applications	5

Associated end user application requirements

COM-94: Interfaces shall facilitate machine learning toolkit forecast

COM-27: Provide enough data for training artificial neural networks

COM-20: The system shall detect patterns in data, without the need to explicitly search for them