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

D8.3 Supply chain pilot I

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1 Executive Summary

The present document is a deliverable of the COMPOSITION project, that is funded by the European Commission's Horizon 2020 Research and Innovation programme, reporting the results of the activities carried out in WP8. The aim of COMPOSITION is to create a digital automation framework (the COMPOSITION IIMS) that optimizes the manufacturing processes by exploiting existing data, knowledge and tools to increase productivity and dynamically adapt to changing market requirements. This is achieved through the connection of supply chain (inter-factory) data and services among enterprises and the connection of value chain (intra-factory) data within a factory, so that it can meaningfully support decision-making. More specifically the developments of COMPOSITION will be demonstrated and validated to five multi-sided pilots. The first pilot, from the biomedical device domain (Boston Scientific Ltd - BSL), focuses on the integrated information management system in a multisided manufacturing process (intra-factory). The second pilot from the lift manufacturing industry (KLEEMANN - KLE) concentrates on intra-factory procedures and on interaction between different companies using the COMPOSITION ecosystem with the agent-based marketplace for collaboration (inter-factory). The third pilot from the recycling industry (ELDIA) focuses on the reduction of the amount of waste that is disposed at the Sanitary Landfill (inter-factory). The fourth pilot from the industrial manufacturing software domain (ATLANTIS - ATL), focuses on the supply chain/Inter-factory cases and will deploy COMPOSITION for software upgrade and deployment. The last pilot from the IT and Telecommunications sector (NEXTWORKS – NXW), serves as a technology and service provider in both the value chain and the supply chain use cases, specifically for factory premises and production line monitoring and management.

This deliverable provides a description of the developments of the first-tier supply chain use cases which promise to add value from a technology, impact and exploitability point of view. The current status and outcomes of "UC – KLE 4 Scrap Metal Collection and Bidding Process" and "UC – ELDIA 1 Fill Level Notification – Contractual Recyclable Material Management", demonstrates that the sensors are successfully installed and are working as expected in the pilots' operational environments. A set of supply chain key performance indicators is provided based on the supply-chain operations reference model (SCOR). On-site technology (including sensors and gateways) is well accepted from both KLEEMANN and ELDIA. Furthermore, a first HMI evaluation for UC-KLE-4 is conducted by participants from KLEEMANN. Finally, supply chain risks that may occur during the implementation of the inter-factory use cases are identified from both pilot and technical partners and methods to manage and mitigate them are presented. The deliverable concludes by presenting the next steps that should be followed for preparing the consortium before the integration and deployment of the COMPOSITION IIMS.

Deliverable "D8.3 Supply chain pilot I" documents the actions that are implemented and the related risks for the two first tier supply chain use cases. D8.3 is part of Milestone (MS) 13 "First iteration of platform deployed and evaluated" and Task 8.3 "Inter-factory Supply Chain Centric Pilot". The document will be updated in "D8.4 Supply chain pilot II", due in M36.

2 Abbreviations and Acronyms

Table 1: Abbreviations and acronyms used in the deliverable

Acronym	Definition
ANN	Automated Neural Network
BMS	Building Management System
CXL	Composition Exchange Language
DFM	Digital factory Model
DLT	Deep Learning Toolkit
EC	European Commission
ERP	Enterprise Resource Planning
HMIs	Human Machine Interfaces
IIMS	Integrated Information Management System
KPIs	Key Performance Indicators
LA	Learning Agent
LoRA	Long Range
MS	Milestone
PPE	Personal Protective Equipment
SCOR	Supply Chain Operations Reference

3 Introduction

3.1 Purpose, context and scope of this deliverable

The purpose of this deliverable is to provide a first description of the demonstration of the supply chain pilots. The document includes information about the current status and outcomes of the top priority industrial supply chain pilots. It presents the set-up and deployment status of these use cases, that are being implemented as demonstrators of the COMPOSITION platform. The key performance indicators (KPIs) of each use case are also provided. Finally, this document focuses on the evaluation of the first developments of the COMPOSITION platform regarding the supply chain. This is performed by the assessment of the installation and operation of sensors, human machine interfaces (HMIs) and related risks.

3.2 Content and structure of this deliverable

The content of this deliverable is structured as follows:

Section 4 presents the status, outcomes and KPIs of the very high overall priority inter-factory use cases. In Section 5 a description of the evaluation of the supply chain pilots is provided. This section includes a brief description on the on-site technology, the human machine interfaces (HMIs), the supply chain risks and the assessment of the installed sensors. In Section 6, the conclusions of this initial demonstrations are provided.

4 Very high overall priority Inter-factory Supply Chain Pilots: set-up and demonstration

In this section a brief description of the first-tier supply chain use cases is provided. Figure 1 presents the hierarchy of the value chain and supply chain use-cases, which is a proposition of the first review of COMPOSITION that has been conducted by the European Commission. As shown in the figure below, UC – KLE 4 “Scrap Metal Collection and Bidding Process” and “UC – ELDIA 1 Fill Level Notification – Contractual Recyclable Material Management” are the highest priority inter-factory use cases. The main focus of this deliverable is the documentation of the current status and outcomes of these two use cases. This is in line with recommendation 1 of the EU from the 2nd review, where it is highlighted that “the project should focus even more on the use cases which are most relevant and promise most added-value from a technology, impact and exploitability point of view”. For both use cases that are related to bins fill level notification, a fill level monitoring sensor has been developed. This sensor provides data to the simulation and prediction tool in order to enable the estimation of the date in which the bin will be full. More information about the simulation and prediction tool is available on *D3.6 Computational Modelling, Simulation and Prediction of Logistics I*.

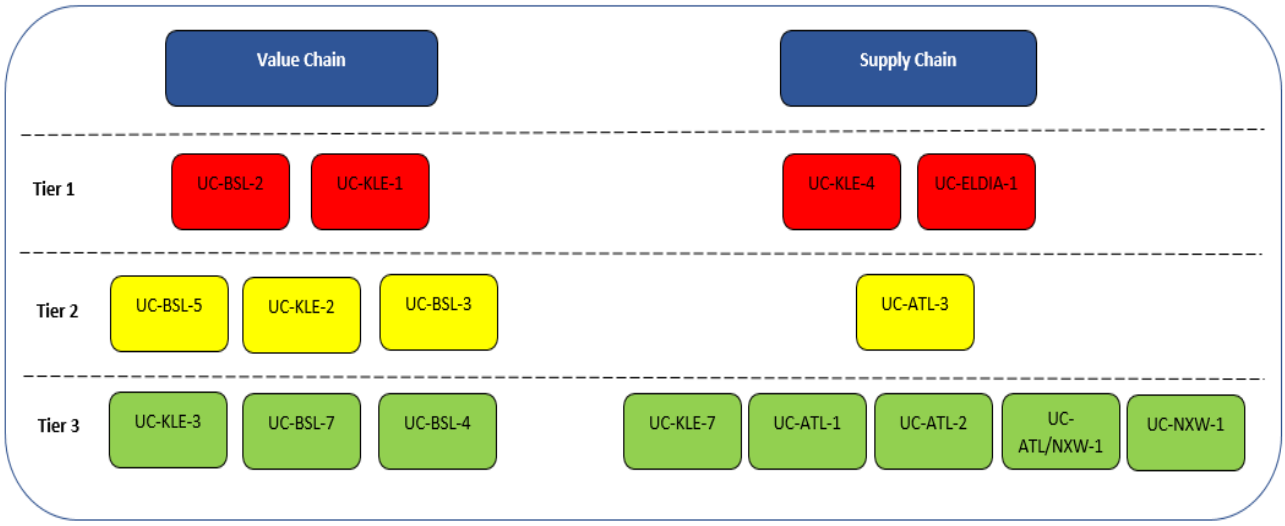


Figure 1: Hierarchy of value chain and supply chain use cases

4.1 UC-KLE-4 Scrap metal collection process and bidding process

The goal of UC-KLE 4 is to optimize scrap metal collection and bidding process in order to achieve better scrap metal prices, minimize costs and receive fast and efficient services. This will be implemented through the automated fill level notification to KLEEMANN and to possible bidders that are registered to the COMPOSITION platform. When the fill level reaches the predefined fill level threshold (e.g. 80%), the action is transferred out of the shopfloor, where KLEEMANN’s marketplace agent generates an automated bidding process. By the end of the bidding process, the matchmaker evaluates the offers and suggests the best one to KLEEMANN’s agent. The final decision is made by the purchasing manager, who accepts the suggested offer or examines other available offers. Finally, the selected waste management company is informed by the system and the scrap metal collection process is completed as soon as the scrap metal is collected.

Current status

As of March 2018 (M19), an ultrasonic sensor is installed at KLEEMANN’s site on the scrap metal container. A protective case for the sensor is constructed at KLEEMANN’s special construction’s factory. An additional case for the gateway is purchased and installed at KLEEMANN’s shopfloor, around 150 meters away from the sensor. It has to be mentioned that there were no existing sensors at KLEEMANN’s equipment and

facilities. The photos below show the installed sensor (Figure 2) and gateway (Figure 3) in their actual position at KLEEMANN's factory.

Figure 2: UC-KLE-4 sensor's position

Figure 3: UC-KLE-4 gateway's position

In addition, a scrap metal dataset is generated by the company's ERP system. The ERP maintains a database including information about the produced scrap metal and the price of it. This set of data is extracted from ERP in excel as a report file. In 2016 around 1,000 tons of scrap metal were produced with an average price of € 120 - 150/ ton.

Outcomes

As already described, UC-KLE 4 starts with the fill level monitoring using the aforementioned fill level sensor's measurements in KLEEMANN factory's scrap metal bin. This is achieved through on-site observations at KLEEMANN's factory and crosschecking with CERTH's fill level data. Fill level measurements are documented in an assessment table, which is presented in section 5.4 of this deliverable. The part of bidding process is still under development.

4.2 UC-ELDIA-1 Fill-level Notification – Contractual wood and recyclable materials management

The goal of UC-ELDIA-1 is to receive an automatic notification about the container fill level, in order to optimize its logistics services and improve the wood and recyclable materials management.

The primary goal of this use case is to be able to receive notifications of the fill level of various containers installed at our customers' facilities, thus facilitating the logistics service and improving the reaction time. ELDIA ERP maintains a database including information about the date of pick up, type, weight and prices of various recyclable materials. This information become available to the project's technical and research partners for further analysis in order to enable possible estimations of the fill level of various containers.

Current status

As of May 2018 (M21), an ultrasonic sensor is installed at ELDIA's site on the scrap metal container. A protective case for the sensor was ordered and constructed by KLEEMANN. The gateway is purchased and installed at ELDIA's office facilities, around 50 meters away from the sensor. It has to be mentioned that there were no existing sensors at ELDIA's equipment and facilities. The photos below show the installed sensor (Figure 4) and gateway (Figure 5) in their actual position at ELDIA's facilities.

Figure 4: UC-ELDIA-1 sensor position

Figure 5: UC-ELDIA-1 gateway's position

Outcomes

As already described, UC-ELDIA 1 starts with the fill level monitoring using the aforementioned fill level sensor's measurements at ELDIA's scrap metal container. This is achieved through on-site observations at ELDIA's container and crosschecking with CERTH's fill level data. Fill level measurements are documented in an assessment table, which is presented in section 5.4 of this deliverable. The part of bidding process is still under development.

4.3 Supply chain KPIs

In this section the key performance indicators (KPIs) of each inter-factory use case will be presented based on the supply-chain operations reference model (SCOR). The SCOR model is considered to be the first cross-industry framework for evaluating and improving supply-chain performance and management (Stewart, 1997). It consists of more than 250 metrics which are categorized in five performance attributes: reliability, responsiveness, agility, costs and asset management efficiency. Reliability, responsiveness and agility are customer-oriented, while costs and asset management efficiency are internally focused (APICS, 2018). The purpose of using this model, is to identify the indicators required for the successful implementation of each use case. The KPIs were selected based on the end goals of each use case. The following table describes the SCOR attributes (see APICS, 2018) and presents the KPIs for each attribute as identified by the pilot partners.

Table 2: Supply chain KPIs

SCOR attribute	Description	KPIs	Inter-factory use case
Reliability	The ability to perform tasks as expected. Reliability focuses on the predictability of the outcome of a process. Typical metrics for the reliability attribute include: On-time, the right quantity, the right quality.	On-time Pickup On-time payments Collection quality (referring to content-material) On-time Pickup Accurate notifications Correct content	UC-KLE 4 UC-ELDIA 1
Responsiveness	The speed at which tasks are performed. The speed at which a supply chain provides products to the customer. Examples include cycle-time metrics.	Reaction time to invitation for pick-up	UC-ELDIA 1
Agility	The ability to respond to external influences, the ability to respond to marketplace changes to gain or maintain competitive advantage. SCOR Agility metrics include Flexibility and Adaptability.	Ability to sub-contract (in case of extreme number of notifications for pick-up or any unforeseen factors)	UC-ELDIA 1
Costs	The cost of operating the supply chain processes. This includes labour costs, material costs, management and transportation costs. A typical cost metric is Cost of Goods Sold.	Cost of material Transportation costs General expenses Price per load Warehousing costs (double-handling cost)	UC-ELDIA 1 UC-KLE 4
Asset	The ability to efficiently utilize assets.	Utilization of own trucks	UC-ELDIA 1

Management Efficiency (Assets)	Asset management strategies in a supply chain include inventory reduction and in-sourcing vs. outsourcing. Metrics include: Inventory days of supply and capacity utilization.	vs outsourcing Utilization of own containers vs outsourcing Number of pick-us per truck Number of pick-ups per week	UC-KLE 4

The use of KPIs is very important for both KLEEMANN and ELDIA, that want to measure their performance and improve their operations based on specific points of reference. Monitoring KPIs and acting properly and immediately will help the supply chain pilots visualize their performance. For example, when a KPI (e.g. on-time pickup) fluctuates, the manager sees the delay and can take specific measures to address the situation, such as switching to a local waste management company.

5 Supply Chain Pilot Evaluation

5.1 On-site technology

Regarding the technology infrastructure, it has to be noted that there were no existing sensors on the waste bins. For both uses cases, a fill level monitoring ultrasonic sensor was developed. The sensor provides data to the simulation and prediction tool in order to enable the estimation of the date in which the bin will be full. More specifically, it captures raw measurements of distance of the waste heap from the deployment point. Data is transferred via the LoRa low power protocol to the LoRa Gateway. The gateway is connected to the internet via Ethernet or Wi-Fi. Finally, the Building Management System (BMS) component of the project will be the destination platform.

Overall, the installed on-site technology is well accepted from both companies with supply chain use cases and until now it is not affecting the day to day operations.

More information about the sensor infrastructure and the on-site technology can be found in deliverables *"D3.6 Computational Modelling, Simulation and Prediction of Logistics I"* led by CERTH and *"D7.6 On-Site Readiness Assessment of Use Cases Based on Existing Sensor Infrastructure I"* led by TNI-UCC.

5.2 Human Machine Interfaces (HMIs)

Evaluation sessions were conducted at KLEEMANN in Kilkis. It was planned by FIT and ATL and the most suitable personnel from KLE participated on the sessions.

The evaluation focused on the HMIs of the INTER-factory use case KLE-4 Scrap metal collection process and bidding process and was conducted as cognitive walkthrough. At this, participants were guided through the evaluation by a list of commonly used tasks. More details about the evaluation process can be found in *D8.8 Final evaluation of the COMPOSITION IIMS platform*. Furthermore, details about the current state of all HMIs and what changes will be made based on the evaluation results, will be included in *D5.5 - Human-Machine-Interfaces for direct interaction with the factory environments I* (November 2018).

Generally, the HMI was well received providing most of the necessary information needed for the scrap metal fill level and bidding process. The participants' suggestions contained the need for more criteria in the bidding process and some changes in the visual elements of the HMIs. Furthermore, proposals for further enhancement and use of the HMI in UC-KLE-7 Ordering raw materials were discussed, e.g. for the reverse process of buying instead of selling in a bidding process.

Dedicated evaluation sessions for the use case ELDIA-1 Fill-level notification – Contractual Wood and Recyclable materials management will be conducted later in the project.

5.3 Supply chain risks

In this section supply chain risks that may occur during the implementation of the inter-factory use cases are identified and methods to manage and mitigate them are presented. This process is documented in the following risk assessment tables. Two main types of risks are identified by the consortium.

1. Pilot risks: risks associated to the end-user
2. Technology risks: risks associated to technology failures that may result in breakdowns

Table 3: Risk Matrix

		Severity			
		NEGLIGIBLE small/unimportant; not likely to have a major effect on the operation of the event / no bodily injury to requiring minor first aid injury	MARGINAL minimal importance; has an effect on the operation of event but will not affect the event outcome / requires medical treatment	CRITICAL serious/important; will affect the operation of the event in a negative way / suffers serious injuries or medical treatment of minors	CATASTROPHIC maximum importance; could result in disaster/death; WILL affect the operation of the event in a negative way / death, dismemberment or serious injury to minors
Probability	LOW This risk has rarely been a problem and never occurred at a college event of this nature	LOW (**1**)	MEDIUM (**4**)	MEDIUM (**6**)	HIGH (**10**)
	MEDIUM This risk will MOST LIKELY occur at this event	LOW (**2**)	MEDIUM (**5**)	HIGH (**8**)	EXTREME (**11**)
	HIGH This risk WILL occur at this event, possibly multiple times, and has occurred in the past	MEDIUM (**3**)	HIGH (**7**)	HIGH (**9**)	EXTREME (**12**)

Table 4: Explanation of Risk Ranking

Explanation of Risk Ranking		
LOW	MEDIUM	If the consequences to this event/activity are LOW / MEDIUM, your group should be OK to proceed with this event/activity. It is advised that if the activity is MEDIUM, risk mitigation efforts should be made.
HIGH		If the consequences to this event/activity are HIGH, it is advised that you seek additional event planning support.
EXTREME		If the consequences to this event/activity are EXTREME, it is advised that you **do not hold** this event without prior consultation with Risk Management.

5.3.1 Pilot risks

Table 5: End-user risks

List All Activities/Use Case *Your activity name*	**Associated Risk(s)** *Risk(s) associated with the activity*	**Severity** *Level of impact*	**Probability** *The chances of that risk happening*	**Risk Score** *Risk score, found by combining impact and probability on the risk matrix*	**Method(s) to Manage/Mitigate the Risk** *A list of methods you will use to minimize the chances of the risk happening and/or the resulting damages of the risk*
Installation of sensor on open top scrap metal container (UC-KLE-4)	1. Interrupt collection process 2. Injury to installers 3. Interfere with the normal operation of recycling waste collection	1. Marginal 2. Critical 3. Critical	1. Low 2. Low 3. Medium	1. Medium (4) 2. Medium (6) 3. High (8)	1. Arrange a specific time for installation that does not interrupt the collection process. 2. Ensure and inspect that all work is performed based on company's health and safety policy and procedures and that personal protective equipment (PPE) is used. 3. Educate forklift operators on how to collect recycling waste without obstructing the normal operation and without damaging the sensor case
Scrap metal collection (UC-KLE-4)	1.Wrong fill level notification of scrap metal	1. Critical	1. Medium	1. High (8)	1.Check the fill level and report the failure of the system to provide accurate data. The report should be communicated to the technical team responsible for the notification.

Bidding process (UC-KLE-4)	1. Wrong notifications (a-Only the selected company was notified, b-the pick-up notification for waste was not delivered, c-The arranged date overlaps with another pick-up process, d-Late notification for pickup date) 2. Late payment 3. Late pick up	1. Critical 2. Critical 3. Critical	1. High 2. High 3. High	1. High (9) 2. High (9) 3. High (9)	1.Thorough check – audit of the bidding process. Confirm transactions via telephone or e-mail and notify selected and not selected companies 2. Inform the scrap metal company about the late payment via telephone and request for payment 3. Inform the scrap metal company about the late pick-up via telephone and request pick-up
Bidding process (UC-KLE-7)	1.Wrong raw materials arrive in the factory with delays 2. Wrong notifications (neither the best price nor the quality of the raw materials has been achieved through the IIMS)	1. Critical 2. Critical	1. High 2. High	1. High (9) 2. High (9)	1. Inform the supplier and/or distributor about the arrival of wrong materials via telephone and request for the right raw materials. Ensure that the right raw materials arrive at the factory and the wrong raw materials are returned. 2. Thorough check – audit of the bidding process. Confirm transactions via telephone or e-mail and notify selected and not selected companies. If prices and quality are not the agreed ones, return the raw materials to the supplier and request the agreed ones.
Installation of sensor on an open top	1. Damage Sensor Case 2. Interrupt loading	1.Critical 2.Marginal 3.Critical	1.Low 2.Low 3.Low	1.Medium (6) 2.Medium	1.Educate participants regarding the

container (UC-ELDIA-1)	process 3. Injury to installers (technicians)			(4) 3.Medium (6)	sensor activity. The sensor case is mounted on the container, so extra attention needs to be paid. 2.Educate forklift and loader operators in order to avoid loading from the sensor's position. 3.Ensure all company's health and safety policies are implemented.
Notification of fill level and optimal route choice (UC-ELDIA-1)	1. Incorrect notification of fill-level 2. Incorrect choice of optional route 3. Misunderstandings with customers	1. Critical 2. Critical 3. Critical	1. Medium 2. Medium 3. Low	1.High (8) 2.High (8) 3.Medium (6)	1.Educate container loaders for proper and equal filling of container. 2.Educate Logistics manager to double check fill level readings 3.Explain the methodology to customers.
Integrate External Product into Own Solution (UC-ATL/NXW-1)	1.Wrong output from the external product (with respect to what expected) 2. Wrong connectors with COMPOSITION ecosystem	1. Critical 2. Negligible	1. Low 2. Low	1.Medium (6) 2. Low (1)	1. Prepare preliminary test phase, in order to ensure that the output is right 2. Check that the connectors are compliant with COMPOSITION interfaces
Decision Support over Marketplace (UC-NXW-1)	1.Wrong output from the decision support tool 2. No data available for the analysis 3. Delays in providing the requested output 4. Damage production machines involved (for wrong configuration)	1. Critical 2. Critical 3. Marginal 4. Critical	1. Medium 2. High 3. Medium 4. Low	1.High (8) 2.High (9) 3. Medium (5) 4. Medium (6)	1. Confirm correctness of the output with experienced technician, before proceeding 2. Ensure that requirements for the analysis are met 3. Check with analysis tool provider for possible solutions 4. Confirm correctness of the output with experienced technician, before proceeding

5.3.2 Technology risks

Table 6: Technology risks

List All Components *Your activity name*	**Associated Use case(s)** *Use case(s) associated with the activity*	**Associated Risk(s)** *Risk(s) associated with the activity*	**Severity** *Level of impact*	**Probability** *The chances of that risk happening*	**Risk Score** *Risk score, found by combining impact and probability on the risk matrix*	**Method(s) to Manage/Mitigate the Risk** *A list of methods you will use to minimize the chances of the risk happening and/or the resulting damages of the risk*
COMPOSITION Virtual Marketplace provides ranking of suppliers	1. UC-ATL all	1. COMPOSITION Virtual Marketplace does not provide ranking. 2. The ranking provided by the COMPOSITION Virtual Marketplace is biased.	1. Critical 2. Critical	1. Low 2. Low	1. Medium (6) 2. Medium (6)	1. COMPOSITION Virtual Marketplace takes into account criteria posed by the Requester. 2. COMPOSITION Virtual Marketplace has security features embedded using blockchain based technology to avoid non authorized access and intervention.
COMPOSITION Security Framework	1. ALL	1. Unauthorized access (malicious or accidental) 2. Misuse of information (or privilege) by an authorized user 3. Data leakage or unintentional exposure of information 4. Loss of data 5. Disruption of service or productivity	1.Critical 2.Critical 3.Critical 4.Critical 5.Catastrophic	1. Low 2. Low 3. Low 4. Low 5. Low	1.Medium (6) 2.Medium (6) 3.Medium (6) 4.Medium (6) 5.High (10)	1. COMPOSITION Security Framework provides strong authorization mechanisms based on EPICA 2. Continuous learning about the data and information management 3. Authentication and authorization management

						using Keycloak and EPICA 4. Data replication policies 5. Distributed architecture with backup instances running
COMPOSITION Shop Floor Connectivity / BMS	1.UC-KLEall 2.UC-BSLall	1.Data is not available due to connectivity problems 2.Data from shop-floor is incomplete 3.Broker is down 4. Sensors are not working or get damaged due to environmental factors	1. Critical 2. Critical 3. Critical 4. Critical	1. Medium 2. Low 3. Medium 4. Medium	1. High (8) 2. Medium (6) 3. High (8) 4. High (8)	1. Connectivity must be constantly monitored, notifications must be sent in case of downservice 2. An initial trial phase is performed to test the robustness of the system 3. Broker connectivity must be monitored 4. Cases have been created in order to protect sensors. Sensors are tested in lab and after that they deployed to the pilots' sites for further testing before the permanent installation.

COMPOSITION data persistence	1.UC-KLE all 2.UC-BSL all	1.Storage queries request excessive amount of data with a single call 2.After production server's reboot BMS or DFM storage components stop and new data are not stored to the data bases anymore	1.Critical 2.Critical	1.High 2.Medium	1. High (8) 2. High (9)	1.Queries results must be limited by the data persistence component 2. Use of Portainer for Docker containers deployment and Set Restart Policy to Unless Stopped. This is to make sure containers restart after a system reboot
COMPOSITION Virtual Marketplace Matchmaking Processes	1. UC-ATL 2. UC-KLE 4 3. UC-KLE 7	COMPOSITION Marketplace does not suggest the correct list of possible suppliers or the best available offer	1.Critical	1.Low	1.Medium	1.COMPOSITION Matchmaker takes into account different qualitative and quantitative criteria in order to perform effective matching. Moreover, many automated tests have been applied and integration tests with the agents as well.
Design of HMI for Marketplace Management Portal	1.INTER-Factory	1.Interface is not understood by the user and tasks cannot be fulfilled	1.Critical	1.Low	1.Medium (6)	1.Evaluate the HMIs with end users to make sure it is understandable, and educate users who are working with the HMI.
IoT Learning Agent	1.BSL II 2.ELDIA I	1.The agent do not process the data and delivers to DLT and front-ends 2.The agent do not forward the data	1.Marginal 2.Marginal	1.Medium 2.Medium	1.Medium (5) 2.Medium (5)	1.The deployment of several instances of the same service will allow the instant recovery in case one fails 2.Same as (1).

						Additionally, we have secondary systems that could take this task in case the LA fails.
COMPOSITION Cloud Servers	1.UC-KLE all 2.UC-BSL all 3.UC-ATL all	1. Servers are unreachable due to technical issues 2. Servers are unreachable for scheduled maintenance 3. Data is lost due to server failure 4. Data is stolen due to security breach	1.Critical 2.Marginal 3.Critical 4.Critical	1.Low 2.Medium 3.Medium 4.Low	1.Medium (6) 2.Medium (5) 3.High (8) 4.Medium (6)	1.Provide replica servers and load balancers to avoid single point of failure. 2. Inform all stakeholders about scheduled updates, possible schedule updates during off-peak hours to minimize the operational effects. 3. Provide offshore replicas of persistent data. 4. Utilize state of the art security mechanisms, deploy security patches as soon as they are made available, adopt common security practices in all aspects of the system from infrastructure to end-user services.
Deep Learning Toolkit for price prediction	1.UC-ELDIA-1 2.UC-KLE-4 3.UC-KLE-7	1. Predicted trends are not accurate 2. Input of wrong data for monthly reports	1. Marginal 2. Critical	1. Medium 2. Low	1. Medium (5) 2. Medium (6)	1. Predictions will improve over time 2. There is no unrolling functions in ANNs. Next input might require data compensation

Message exchange between agents	1. UC-KLE-4 2. UC-ELDIA-1, 3. UC-KLE-7, 4. UC-ATL-3 5. UC-ATL/NXW-1	1. Requester Agent fails during negotiation/message exchange 2. Supplier Agent fails during negotiation/ message exchange 3. The message is not CXL-compliant 4. The marketplace infrastructure fails during negotiation/ message exchange	1. Critical 2. Critical 3. Critical 4. Critical	1. Low 2. Low 3. Low 4. Low	1. Medium (6) 2. Medium (6) 3. Medium (6) 4. Medium (6)	1. Stop current negotiation, restarting it when agent will be back online. 2. Withdraw from current negotiations. 3. Always check the message against CXL before sending it out. Do not accept CXL-not-compliant messages. 4. Stop all the current negotiations. Provide high availability and redundancy for Agent Management System.
Start new negotiation process	1. UC-KLE-4 2. UC-KLE-7	1. Requester/Supplier Agent fails before starting negotiation, after IIMS input has been received	1. Critical	1. Low	1. Medium (6)	1.Store the IIMS input in a backup system.
Agent registration on marketplace	1. UC-KLE-4 2. UC-ELDIA-1, 3. UC-KLE-7 4. UC-ATL-3, 5. UC-ATL/NXW-1	1. White pages service fails before registering agent 2. Registration request has a wrong format	1. Critical 2. Marginal	1. Low 2. Low	1. Medium (6) 2. Medium (4)	1. Provide fail over mechanisms for White pages service. 2. Always stick to standard request before sending it out.
Matchmaking results from the COMPOSITION Marketplace	1. UC-ATL-all	1. Requesters fail to correctly register their needs and requirements to the ecosystem to specific topics 2. Suppliers fail to correctly register their products and services to the ecosystem to specific topics	1. Critical 2. Critical	1. Medium 2. Low	1.High (8) 2.Medium (6)	1. Requesters are asked to follow specific topics, connected to the COMPOSITION ontology framework. 2. Suppliers register their products and services according to the COMPOSITION ontology

						framework.

5.4 Synchronization between reality and simulation

The challenge of synchronising the digital and physical world while simultaneously addressing the security and IPR protection requirements still exists. In this phase of the project, where the platform is still under development, pilot partners can evaluate the status and operation of sensors through on-site observations. In collaboration with technology partners, an assessment table is developed in order to document the results of the test studies regarding the evaluation of the installed sensors on the pilot's shopfloor. The table consists of 6 columns including information on the date, time, level of scrap metal (photo), on-site estimation from one pilot's employee, the sensor fill level as shown in the technical partner's lab, and the difference between the estimated level and the sensor level. The sensors are evaluated through iterative on-site testing by the same employee (one from KLEEMANN and one from ELDIA).

Overall, the sensors provide accurate measures, which are very close to the on-site observation measures. Indicative results from KLEEMANN's and ELDIA's shopfloors are presented in the following tables.

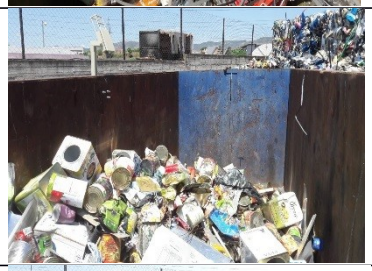
As we observe in both tables, the comparison between on-site observations and sensor fill level data, demonstrates the robustness of the measurements since they are all but one, quite close. This is also confirmed by the low absolute averages of differences (11% for KLE and 4% for ELDIA) and the low standard deviations (0,17 for KLE and 0,03 for ELDIA). However, a limitation of the above measurements is that the sample of observations in both companies is very low and more data is needed to provide more accurate results. It is also observed, that only one measurement shows a difference of 50% and an error, which is probably related to material implications. Scrap metal and more specifically metal swarf, may cause implications to the measurements of ultrasonic sensors because the sound may not come back to the sensor. This is subject to review and will be observed until the end of the project in order to justify the aforementioned issue based on more data.

Table 7: UC-KLE 4 sensor assessment

Date	Time	Photo	On-site estimated fill level	Sensor fill level	Difference
24/05/2018	10:17		50%	46%	4%
24/05/2018	10:18		50%	46%	4%

30/05/2018	13:47		90%	100%	10%
05/07/2018	13:06 13.16		50% 50%	-2 100%	error 50%
05/07/2018	13.36		50%	51%	1%
19/07/2018	11.10		25%	27% 32%	2% 7%

Table 8: UC-ELDIA 1 sensor assessment

Date	Time	Photo	On-site estimated fill level	Sensor fill level	Difference
29/05/2018	14:57		70%	62%	8%
01/06/2018	14:16		60%	58%	2%
04/06/2018	08:34		60%	55%	5%
04/06/2018	16:12		60%	51%	9%
06/06/2018	12.57		70%	61%	1%
20/06/2018	10:59		10%	10%	0%

6 Conclusion

This deliverable is the result of an ongoing process, which describes the actions taken regarding the implementation of the top priority supply chain use cases. It represents the current status of Task 8.3 “Interfactory Supply Chain Centric Pilot” of WP8. Regarding the set up and demonstration, the sensors have been successfully installed and are running at KLEEMANN’s and ELDIA’s shopfloors. The data is successfully transferred from both supply chain pilots to COMPOSITION’s related components. Overall, the deployed systems combine the technical work that was developed in the technical work packages WP3, WP4, WP5 and WP6. The different components were integrated in the scope of WP7. Finally, a list of supply chain KPIs is identified by KLEEMANN and ELDIA. This list provides indicative KPIs and maybe extended until the end of the project.
Regarding the supply chain pilot evaluation, the installed on-site technology is well accepted from both supply chain pilots. The HMI for UC-KLE-4 is well received providing most of the necessary information needed for the scrap metal fill level and bidding process. The pilot and technology risks are identified and methods to mitigate them are presented, as recommended in the second project review by the EC. The low differences between on-site observations and sensor fill level data, demonstrate the robustness of the measurements. Finally, it is observed that metal swarf, may cause implications to the measurements of ultrasonic sensors.

Based on the supply chain analysis performed in the previous sections, this deliverable concludes on a number of next steps that could be effectively be deployed in order to successfully install and deploy the COMPOSITION platform in the pilot’s application fields and sites. These steps are:

1) Focus on the integration of tier 1 supply chain use cases.
2) Real – time data from supply chain partners should be provided continuously to the system.
3) KPIs should be further discussed and developed with help from technical partners in order to improve the system’s performance and the overall supply chain management performance.
4) Possible interventions of COMPOSITION components on existing supply chain operations should be addressed.
5) Potential supply chain risks or bottlenecks and mitigation methods should be continuously reviewed and updated.
6) A testing and demonstration framework to evaluate each supply chain use case should be developed.

7 List of Figures and Tables

7.1 Figures

7.2 Tables

8 References

(APICS, 2018) APICS (American Production and Inventory Control Society) (2018). Understand the Structure of SCOR, available at: http://www.apics.org/apics-for-business/benchmarking/scormark-process/scor-metrics, accessed on 07/08/2018

(Stewart, G., 1997) Stewart, G. (1997). Supply-chain operations reference model (SCOR): the first cross-industry framework for integrated supply-chain management. Logistics information management, 10(2), 62-67.