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D5.6 Human-Machine-Interfaces for Direct Interaction with the Factory II

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Theofilos Mastos (KLE)	2018-11-29	Minor changes required

Index:

1 Executive Summary

This deliverable presents the updated results of the task T5.4, which is about the development of inter- and intra-factory human-machine-interfaces (HMIs) that enables users to interact with the COMPOSITION system. The HMI design is driven by initial requirements collected in both, WP2 (D2.1) and WP5 activities. For the initial GUIs, the use cases defined in D2.1 were considered; however, their prioritization was changed after the T5.3 started. This is why use cases of higher priority might not always have HMI drafts of highest detail.

The methodology is shortly described in section 4. A more detailed look at it and also a research on the role of HMIs in the Industry 4.0 is documented in D5.5, which is the initial version of this deliverable. Several design methods offered by the applied user-centred design framework have been applied during all project phases, for example interviews, guided tours through the factory floors, scenario thinking, storyboards, activity analyses, prototyping and user testing.

In this document, wireframes of use cases are presented whose processing had not yet started a year ago. Furthermore, implementation of higher prioritized use cases was evaluated with potential users from BSL and KLE. Results and design recommendations or updated implementations are described in Section 5.

2 Acronyms

Acronym	Explanation
CPS	Cyber-Physical System
Dx.x	Deliverable x.x
HMI	Human-Machine-Interfaces
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
PCBA	Printed Circuit Board Assembly
UCD	User-centred Design
Tx.x	Task x.x
WP	Work Package

3 Introduction

3.1 Purpose, context and scope of this deliverable

This deliverable provides an overview of the updated results of T5.3 Advanced Human-Machine-Interfaces for Direct Interaction with Real-World Objects. The purpose of task T5.3 is the development of work-task oriented user interfaces that support people in CPSs. T5.3 is one of five the subtasks of work package 5 – Key Enabling Technologies for Intra- and Inter-factory Interoperability and Data Analysis.

In this stage of the project, the initial results presented in D5.5 Human-Machine-Interfaces for direct interaction with the factory environments I are revised and prototypes are implemented. This deliverable shows the current state of all specified HMIs and describes the changes that are made. It includes the analysis of the HMI evaluation, conducted on the shop floors of BSL and KLE.

3.2 Content and structure of this deliverable

This deliverable presents the updated drafts and first implementations of HMIs developed for intra- and inter-factory scenarios described as a part of the COMPOSITION project. In Section 4 the user-centred design framework and how it is applied in COMPOSITION is described.

In Section 5 the latest versions of the HMIs, either as wireframe or already implemented and presented at Review 2 in Brussels. The section is divided in Section 5.1, presenting the current HMIs related to the Intra-factory use cases and in Section 5.2 that shows HMIs related to Inter-factory use cases.

Finally, Section 6 describes some corporate design elements that will ensure that throughout the different human-machine interfaces, recurring elements will always look the same way, independent of which partner implemented it.

4 Methodology

Designing relevant interfaces and their interaction requires a structured development process. Therefore, in D5.5 Human-Machine-Interfaces for direct interaction with the factory environments I, the user-centred design framework (International Organization for Standardization, 2010) is described and its application in the COMPOSITION environment.

Figure 1 depicts the UCD framework as an iterative process consisting of 4 phases. Most of the specified HMIs are gone through at least once.

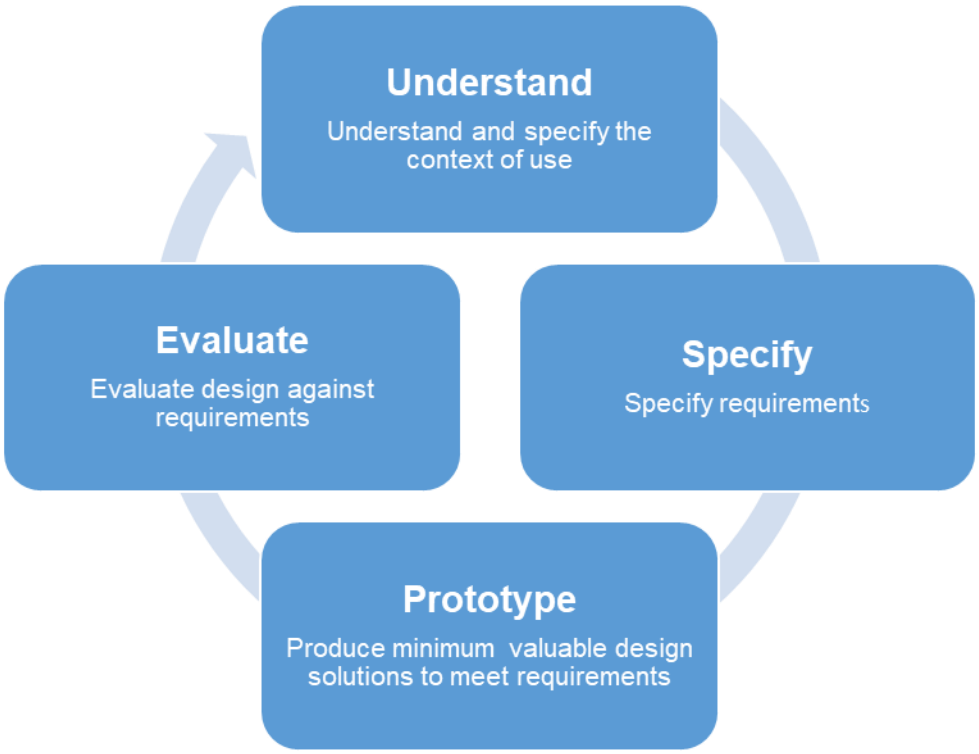


Figure 1: The UCD process adapted from (International Organization for Standardization, 2010)

Further details about methods for requirements gathering and the design process are described in D5.5 Human-Machine-Interfaces for direct interaction with the factory environments I and are applied as described.

5 Interface Prototypes

This section describes the latest versions of the HMIs, either as wireframe or already implemented and presented at Review 2 in Brussels.

5.1 Intra-Factory HMIs

The intra-factory HMIs are being developed in joint workshops with Kleemann and Boston Scientific and intertwined with efforts from Nextworks and CNet (INTER) and Atlantis (INTRA). Intra-factory use cases and HMIs focus on processes inside the factory. The current state is presented in the following sections.

As the project evolved, the prioritization of intra-factory use cases of COMPOSITION had to be adjusted. Table 1 shows which use cases will be further developed within the scope of the project. At the same time, it implies, that the implementation of the intra-factory UC-BSL-1, UC-BSL-4 and UC-KLE-2 will not be continued.

Table 1: Updated prioritization of the intra-factory use cases (July 2018)

Tier	Use case ID	Name	Scenario
1	UC-BSL-2	Predictive Maintenance	Predictive Maintenance
	UC-KLE-1	Maintenance Decision Support	
2	UC-BSL-5	Equipment Monitoring and Line Visualisation	Production Floor Monitoring and Visualisation
	UC-BSL-3	Component Tracking	Material Management
3	UC-KLE-3	Scrap Metal and Recyclable Waste Transportation	Material Management
	UC-BSL-7	Automatic Long-Term Tracking of High Value Material	

The development of a general overview dashboard did not proceed technically. T5.3 focused on the development of use cases, having in mind, that contents shall be reusable in widgets on a dashboard. Therefore, it should be easy to extend the system by a configurable dashboard. If a dashboard will be developed in future, it should either be configured by an admin role to look the same for all users of a specific user role or be configurable per user itself.

5.1.1 UC-BSL-2/UC-KLE-1 – Predictive Maintenance

The following describes the current state of the prototype for the predictive maintenance scenario. The development of the prototype has not yet been completed. The HMIs presented below are based on the sketches from D5.5 and a first implementation, which was evaluated with the help of potential users and implemented with their feedback. The aim of the evaluation was to check whether the users are able to perform their tasks effectively and efficiently with the help of the tool. Therefore, the evaluation was carried out in June and July 2018 as a user test with employees of the pilot partners BSL and KLE on their premises.

While Boston Scientific focuses on noise levels of fans and the temperature and power from the embedded sensors, KLEEMANN monitors the vibrometer/ vibration levels of motors. Although different sensors and data types are used, use cases belonging to the same scenario also require similar functionalities when it comes to the presented information. As a result, several components are reused for both use cases and are described below.

Main interface for Predictive Maintenance/ Maintenance Decision Support

The structure of the HMI and its sub-pages is the same for both use cases. Figure 2 shows the current state of the implementation of KLE's HMI for Maintenance Decision Support. Users can easily recognize if a failure is likely or not. If the probability for a mechanical/ electrical/ hydraulic failure exceeds the limit of 45%, a warning is sent and the colour changes to orange. If the threshold exceeds 85%, an alert is send and the

colour changes to red. If there is no warning or alert, the probability is green. The underlying model is described in D3.9. (Hint: In the current implementation, presented in Figure 2, the colour code blue has the same meaning as green. This will get adjusted soon.)

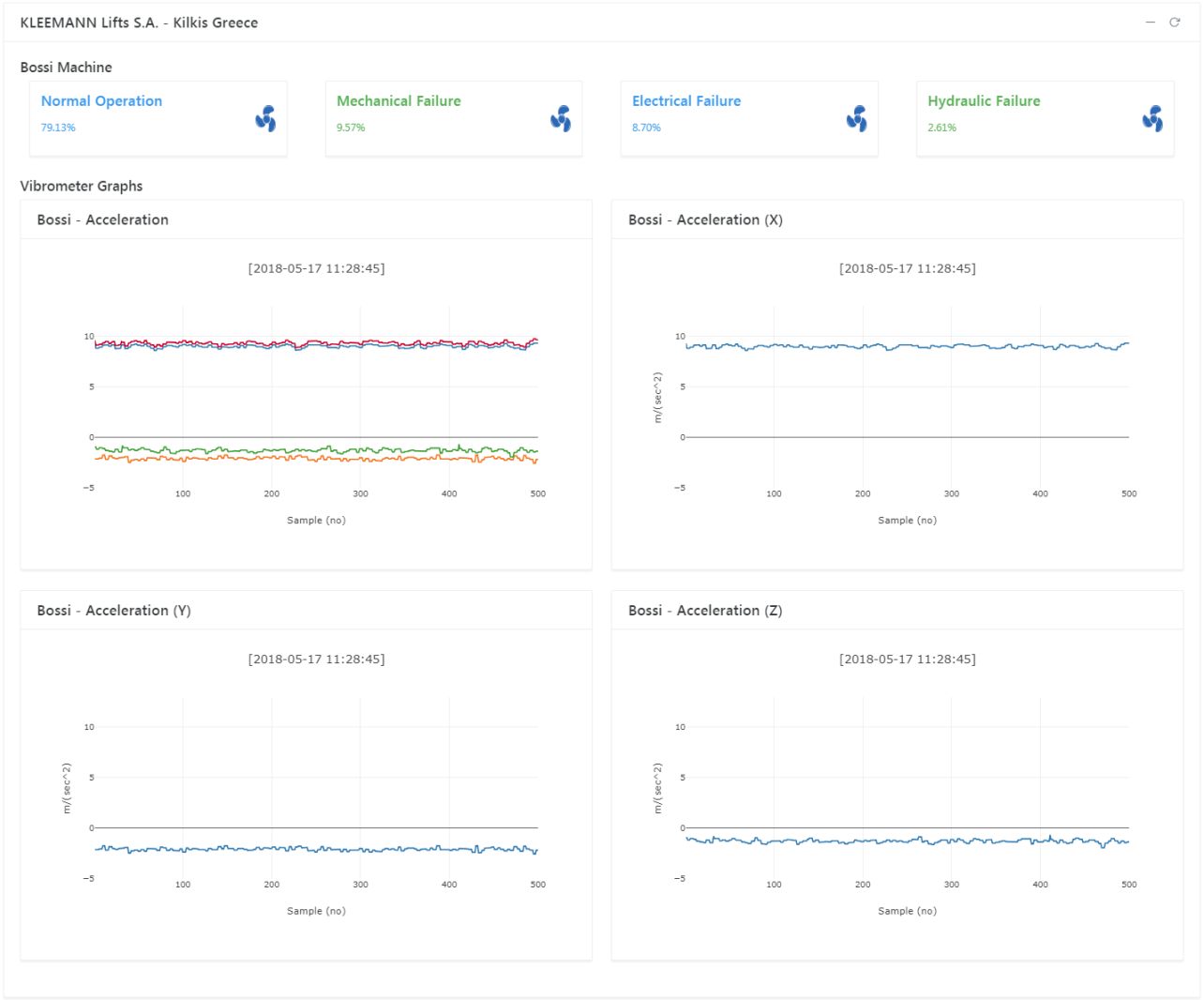


Figure 2: HMI for UC-KLE-1 - Maintenance Decision Support

The boxes in the top of the screen (see Figure 2; normal operation, mechanical/electrical/hydraulic failure) are clickable and provide the user more information if requested. Currently, only the current value (dB) of each individual fan is listed. In case the probability of a failure increases, the user can check whether a fan has (strongly) deviating values in order to react preventively based on this information.

Below that, the vibrometer data is displayed in proper graphs. These provide the user another possibility to detect deviations, which can be an indication of an impending failure.

For UC-BSL-2, this main screen still has to be adjusted. The layout will be the same: in the top row, boxes show the probability of failure for fans. The probabilities are based on the DLT output. For the time being, there is only one prediction that restricts the prediction for the next two and half hours. When the DLT predictions are finalized, there will be different time frames for the prediction and the probabilities of failure. Which additional information can be displayed is still under discussion.

Below the boxes, graphs are used to show the current noise level (dB) for the fans. As soon as the data stream is available through MQTT, the graph will show a combination of the noise level in dBs, the temperature and the power consumption. The combined graph is the most suitable for the BSL operators to get all the needed information in one graph. The graph provides them knowledge at a glance. The fans are grouped by oven, i.e. there is a graph for the Rythmia oven showing all fans. Only one oven is monitored at the time at BSL, but BSL's intention is to extend their sensor network on other ovens, and the visualisation infrastructure already exists.

Sub-page: KPIs

In addition, each oven has its own sub-page, which allows a more detailed view of fan values. As shown in Figure 3, the user can select a specific date, time and fans to plot. A hover effect enables the user to see the specific values at that time (e.g. Aug 1, 2018, 11:24:12am).

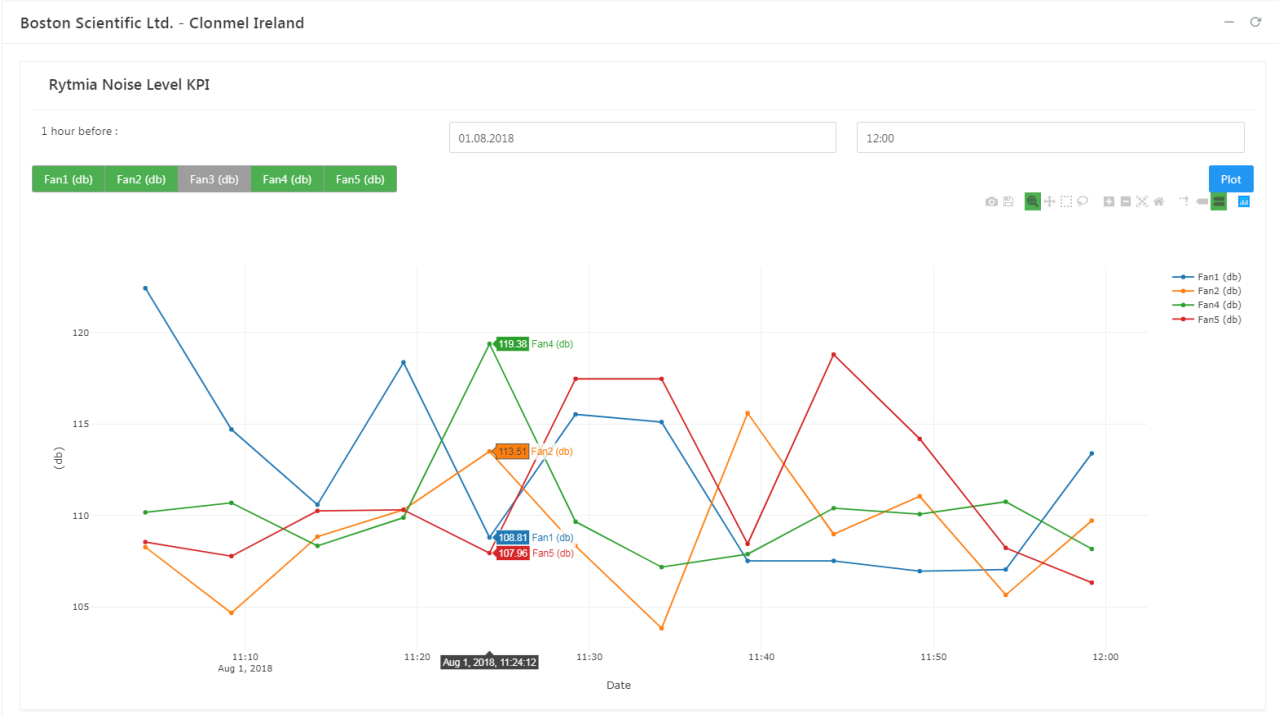


Figure 3: UC-BSL-2 additional view per oven

For UC-KLE-1, the sub-page also contains a plot functionality. As shown in Figure 4, the user can select a time frame (1) and one of the KPIs (2): MTTR, Response Time, Down Time, MTBF, Count. In addition, also the asset/machine (3) and a failure mode (4). Since the KLE's data is coming in in Greek, buttons in (4) are currently labelled in Greek. If it will be changed to English, has to be discussed with users from KLE.

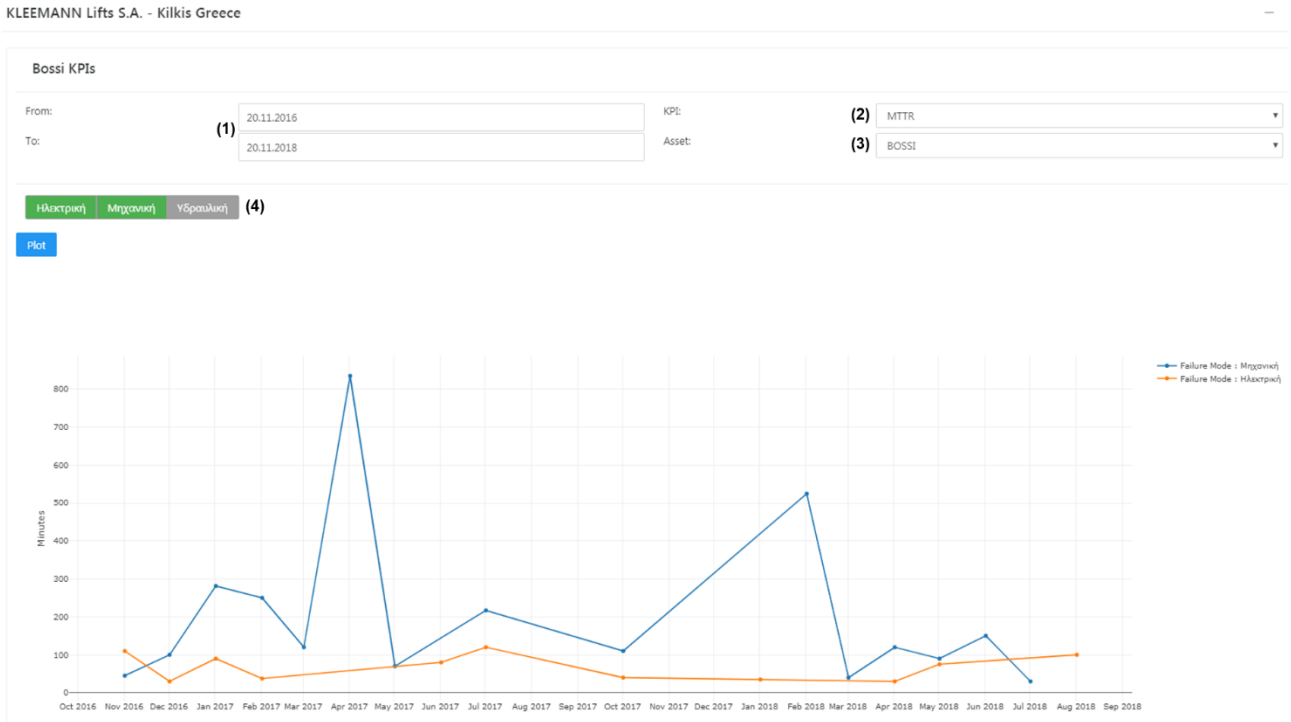


Figure 4: UC-KLE-1 - KPIs

Sub-page: Rule Engine

Another sub-page, which is the same for both pilot partners, is shown in Figure 5. This interface is not yet integrated to the COMPOSITION design, since it is a product from Atlantis (DSS). If COMPOSITION transitions from a prototype to a final product, the DSS would be integrated into the application.

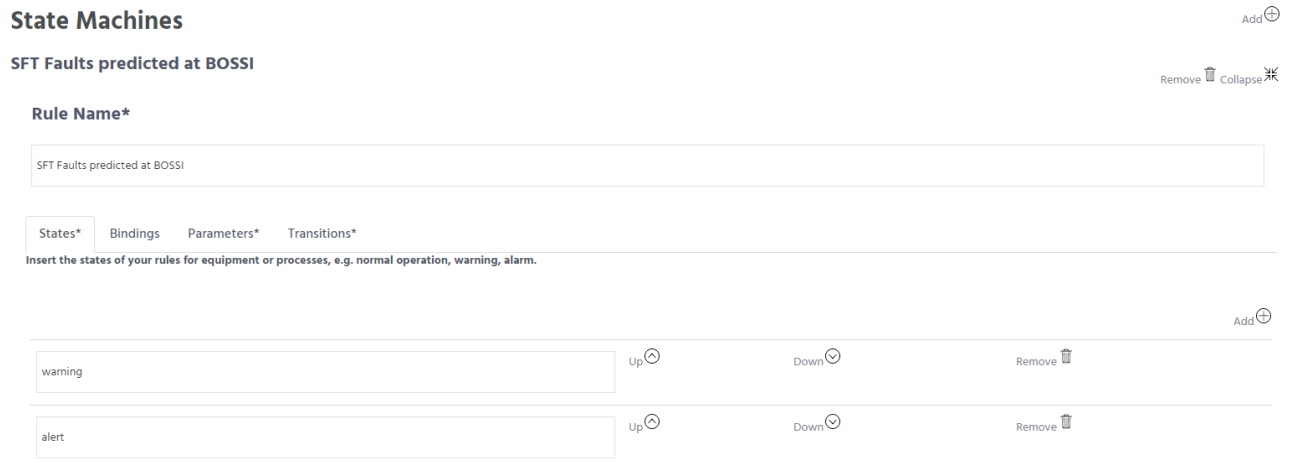


Figure 5: UC-BSL-2 & UC-KLE-1 - Rule Engine

In the upcoming months, the interfaces for UC-BSL-2 and UC-KLE-1 will be adjusted according to the corporate design elements (see Section 6) and, especially UC-BSL-2 is missing core elements for the prediction. Before a final sketch can be created and implemented, some technical restrictions must be clarified.

5.1.2 UC-BSL-3 - Component Tracking & UC-BSL-7 - Automatic Lon- Term Tracking of High Value Material

In D5.5, the basic functionalities and wireframes for UC-BSL-3 and UC-BSL-7 were described. These wireframes were evaluated in an interview with BSL. During this, no problems or objections could be identified.

Due to technical challenges the standalone application “AirFinder” is currently used and provides a basic set of functionalities through an HMI. As soon as the standalone solution provides an API that allows an integration to COMPOSITION, the wireframes can be used for the implementation of the HMI. With the integration in place, a user testing has to be conducted, which might lead to a second design iteration.

5.1.3 UC-KLE-3 - Scrap Metal and Recyclable Waste Transportation (from Bins to Container)

For UC-KLE-3 the solution does not include a graphical user interface. However, before this decision was made, the routes were sketched and a calculation engine was developed by CERTH after discussions with KLE, as shown in Figure 6. The user could have started the calculation manually and would have been shown the shortest way with indication of the sequence. In a discussion based on this, it was figured out, that users do not need a HMI like this. In fact, workers only need to get a notification sent to their phones. The notification will contain the instruction to pick up a bin and the optimal route based on the position of the bins in the factory, i.e. a notification may be as follows: “Bin A is full – go from position C to position D”. An evaluation, embedded into workers’ daily work, has to show, if the notifications are short and explicit enough and if workers will follow them.

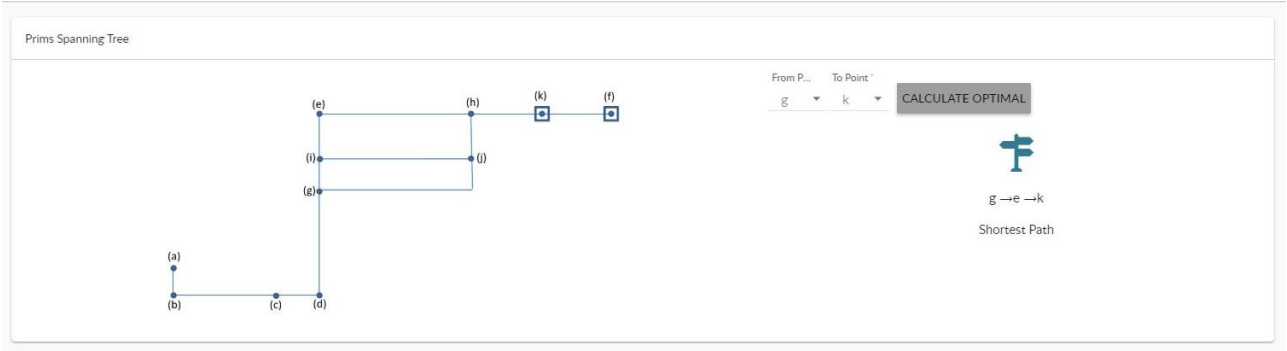


Figure 6: UC-KLE-3 - Sketch for route optimization

There are no regular changes on the position of bins that would require a graphical user interface for setup new or changed bin positions. In the current implementation for COMPOSITION, the setup is done in configuration files.

5.1.4 UC-BSL-5 - Production Floor Monitoring and Visualisation

Since D5.5 was submitted, UC-BSL-1 was decided not to be continued and the focus is on UC-BSL-5. The aim is to have a real time visualisation of the efficiency of BSL's front end PCBA line. Figure 7 shows the implementation done in a first iteration. The user is able to see for each machine how many items are processed compared to the target amount. By clicking on a machine, more details could be presented in the details section on the right.

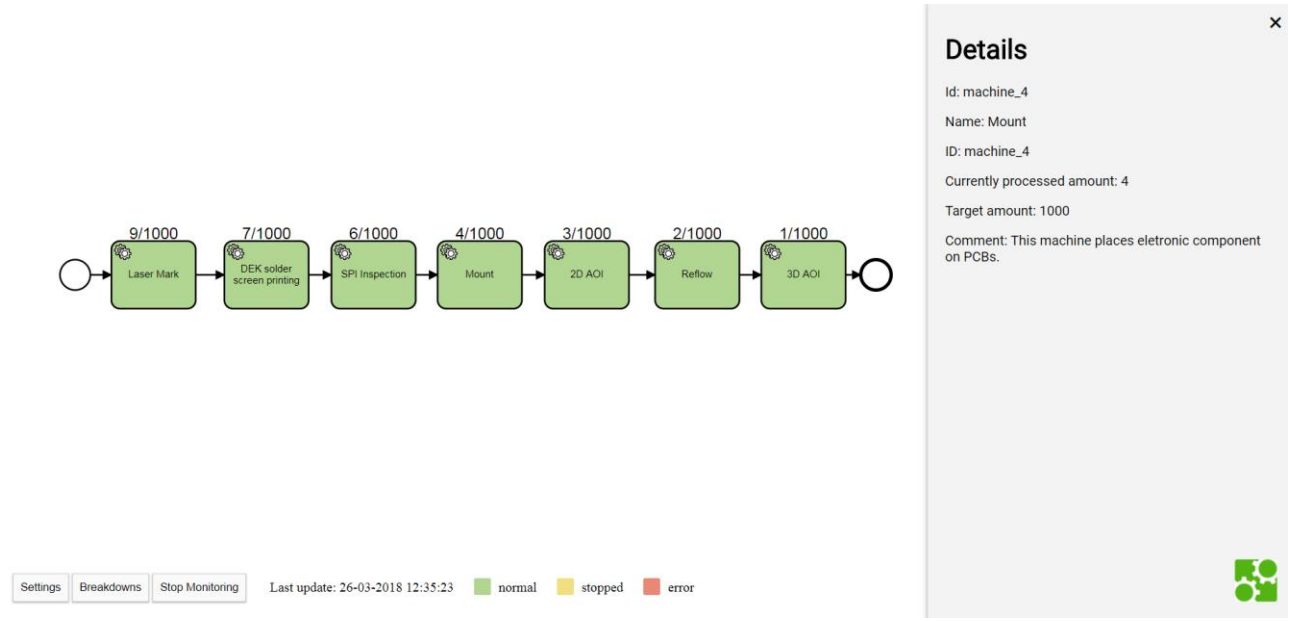


Figure 7: UC-BSL-5 - HMI (first iteration)

After the first iteration, BSL realized that UC-BSL-5 has to cover more functionalities. In an internal workshop, BSL created sketches for four different screens that will belong to UC-BSL-5. Figure 8 shows the sketched main screen. On the left side, the user sees an overall "Line Status" and the sum of produced items ("Quantity"). On the right side, the machines' status is visualized, based on the visualization in Figure 7. Additionally, the user sees some KPIs, e.g. a graph of processed item (targeted vs. achieved). Two further views can be accessed via the buttons "Allocation calendar" and "Line stats".

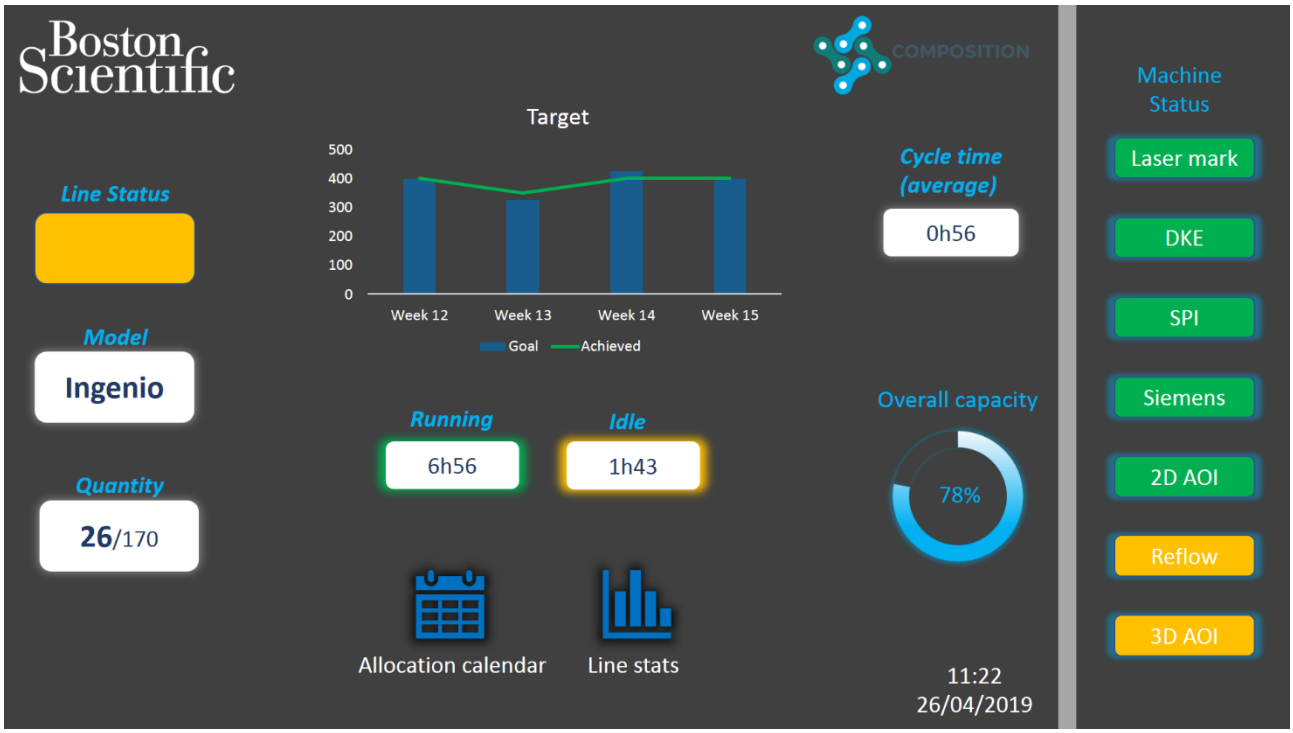


Figure 8: UC-BSL-5 - Main Screen (second iteration)

The “Line stats”, shown in Figure 9, provides the information per machine. In some cases, the user might need additional information, e.g. for predictive maintenance and log file errors. In this case, the user can click on “Details” to get the necessary information displays (see Figure 10).

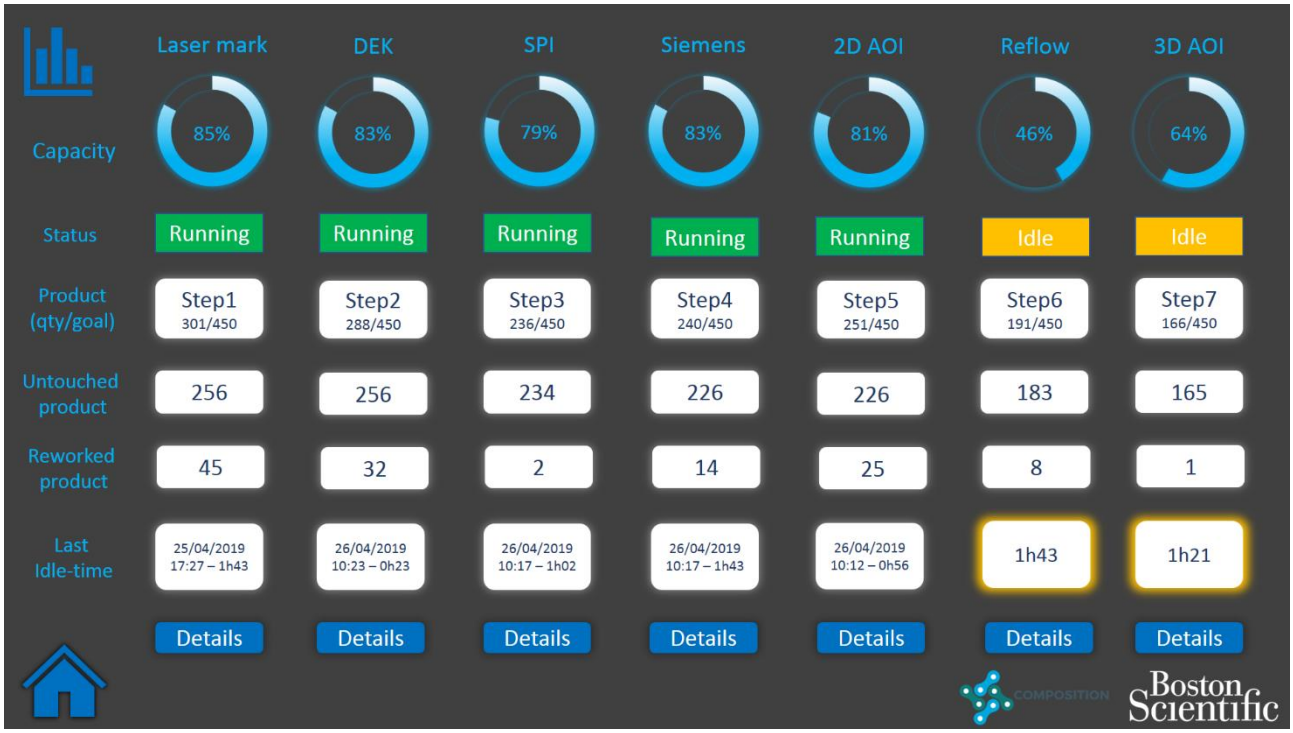


Figure 9: UC-BSL-5 - Line Stats

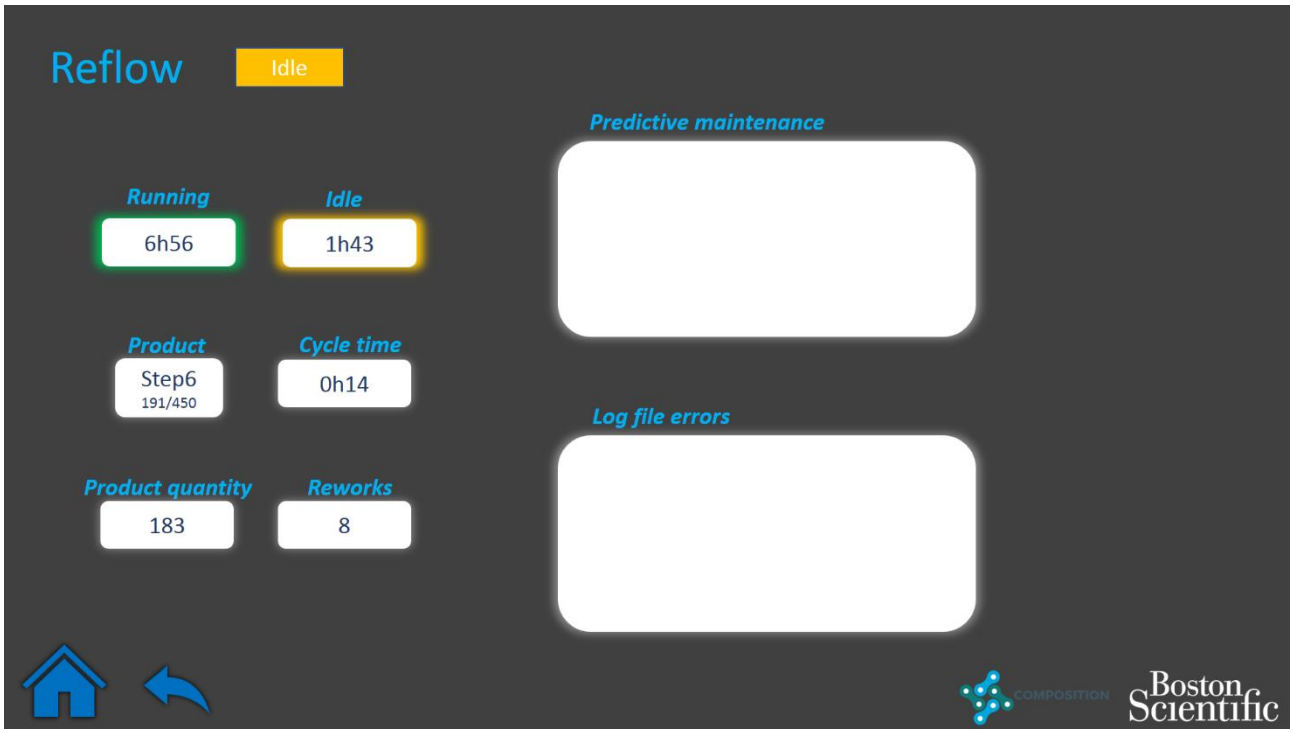


Figure 10: UC-BSL-5 - Machine Details

The “Allocation calendar”, shown in Figure 11, visualizes the line allocation for an entire month. This allocation should be set easily by specific user roles.

Figure 11: UC-BSL-5 - Allocation calendar

The sketches shown (see Figure 7-10) are currently being jointly revised and refined by ATL and BSL to meet all requirements. In the next step, the development of single screens and components will be prioritized. ATL will do the implementation itself.

5.2 Inter-Factory HMIs

As already described in D5.5, many of the inter-factory use cases in COMPOSITION are addressed by the marketplace system, which is implemented in WP6. Only the interfaces for fill-level notifications (UC-KLE-4) is at least partially covered by the HMI task. The inter-factory HMIs are still developed in close collaboration with partners ISMB and NXW. FRAUNHOFER supports with interface concepts and design drafts in order to ensure a common HMI design and the fulfilment of requirements, such as COM-108.

Table 2 lists the inter-factory use cases that will be further developed within the scope of COMPOSITION. The implementation of UC-NXW-1 and UC-ATL/NXW-1 will not be continued within this project.

Table 2: Updated prioritization of the inter-factory use cases (July 2018)

Tier	Use case ID	Name	Scenario
1	UC-KLE-4	Scrap Metal Collection and Bidding Process	Scrap Metal Management
	UC-ELDIA-1	Fill-level Notification – Contractual Wood and Recyclable Materials Management	Wood and Recyclable Material Management
2	UC-KLE-7	Ordering Raw Materials	Supply Chain Management
	UC-ATL-3	Searching for Recommended Solutions	Software Distribution
3	UC-ATL-1	Selling Software / Consultancy	Software Distribution
	UC-ATL-2	Searching for Solutions	
	UC-ATL/NXW-1	Integrate External Product into Own Solution	System Connection over Marketplace
	UC-NXW-1	Decision Support over Marketplace	

5.2.1 UC- KLE-4 - Scrap Metal Management

D5.5 contains a first set of interface prototypes for the bidding process. Those mock-ups are refined and evaluated with end users. Both, the revised version and the insights given by the evaluation for UC-KLE-4 are described in this section.

The first set of prototypes were developed for mobile screens. Now, the prototypes are adjusted for laptop/ desktop screen sizes. In a workshop with ISMB, KLE, ELDIA, NXW and FIT in Augsburg (January 2018), the container monitoring view, single steps of the bidding process and corresponding required information were discussed for both, requester and supplier roles.

HMIs for Container Fill Level Monitoring

Besides the bidding process itself, the UC-KLE-4 requires a HMI to monitor the fill level of containers. Therefore, a mock-up was created (see Figure 12), which was adjusted based on the discussion in Augsburg. Main features included in the user interface are:

- Representing alerts/ warnings
- Current fill level
- Filling prediction
- Historical data
- Current stock price
- Sensor information

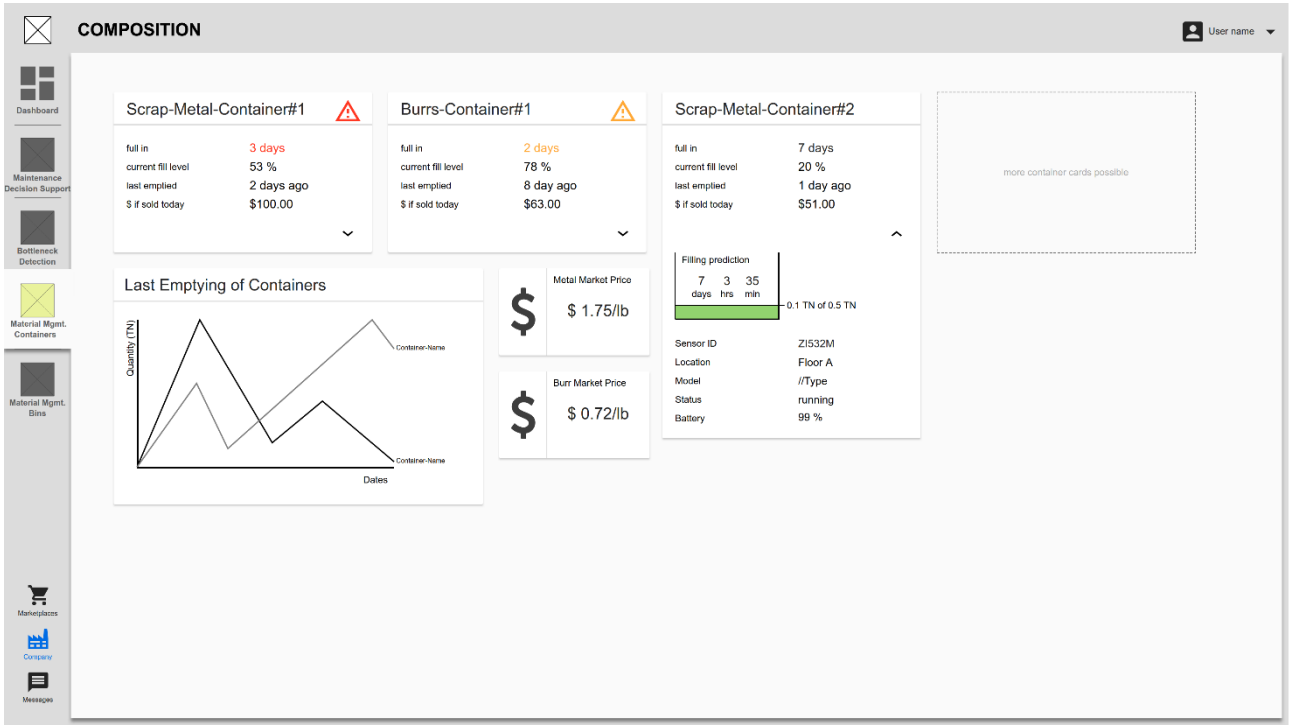


Figure 12: Mock-up to monitor the fill level of containers (UC-KLE-4)

The mock-up was implemented by CNET and is shown in Figure 13. All features listed above are implemented in this interactive prototype. The interface was evaluated with end users at KLEEMANN in June 2018. The HMI was well received by the participants, providing most of the necessary information for the fill level monitoring. However, some visual elements have to be revised:

(1) The icons for alerts and warnings have to represent the status properly. Using an exclamation mark, if the status is good, is misleading.

(2) If a container is in the status alert or warning, highlighting has to be more noticeable.

(3) Symbol for containers' fill level is misleading and its headline is too far away.

Furthermore, users requested that the sequence of containers need to be determined by its filling prediction. Most critical first. This change is applied exemplarily in Figure 14.

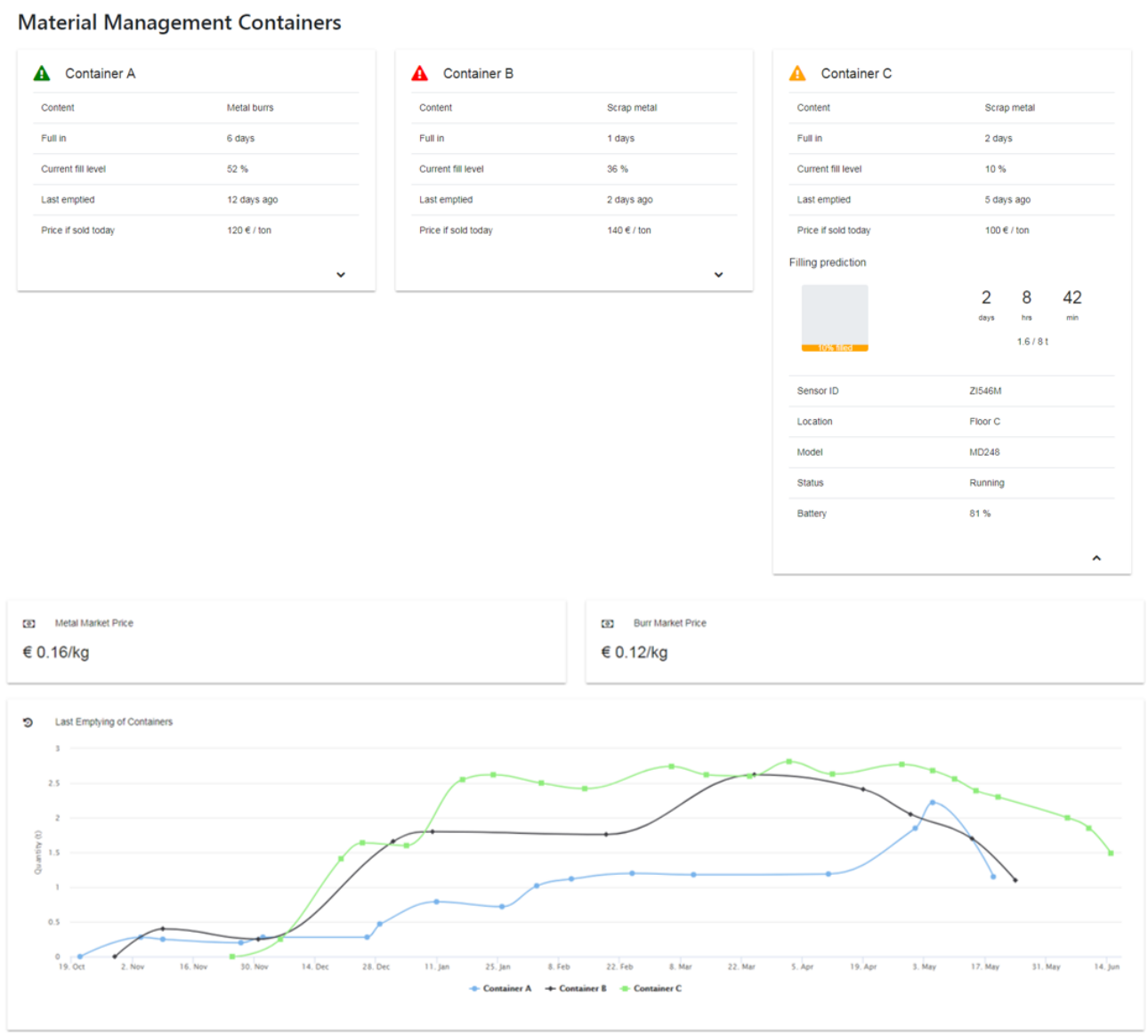


Figure 13: Prototypical implementation to monitor fill level of containers (UC-KLE-4)

Figure 14 shows changes addressing (1) and (2). Those changes will be applied in order to improve the usability:

- Icon for normal status is changed.
- Number of days until a container is full is bold, if status is alert or warning.
- Number of days until a container is full is coloured representing its state.
- Border and box-shadow is coloured representing its state.

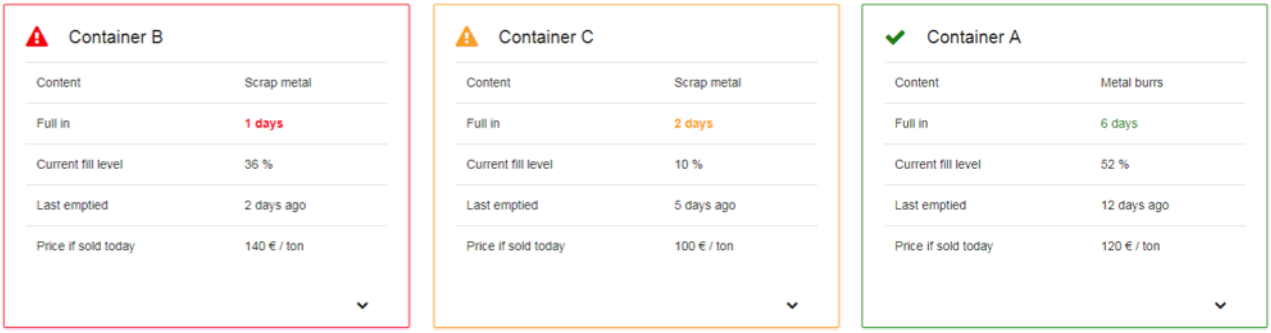


Figure 14: Changes applied to container information cards to improve the usability

To address (3), the information representation is adjusted as shown in Figure 15. During the evaluation, the visualization of the fill level was interpreted as battery level indicator. The rectangle was adjusted slightly (wider than higher) in order to avoid such a misinterpretation. Furthermore, additional headlines are added and positioned closer to the elements. Users confirm a better intelligibility due to the proposed changes.

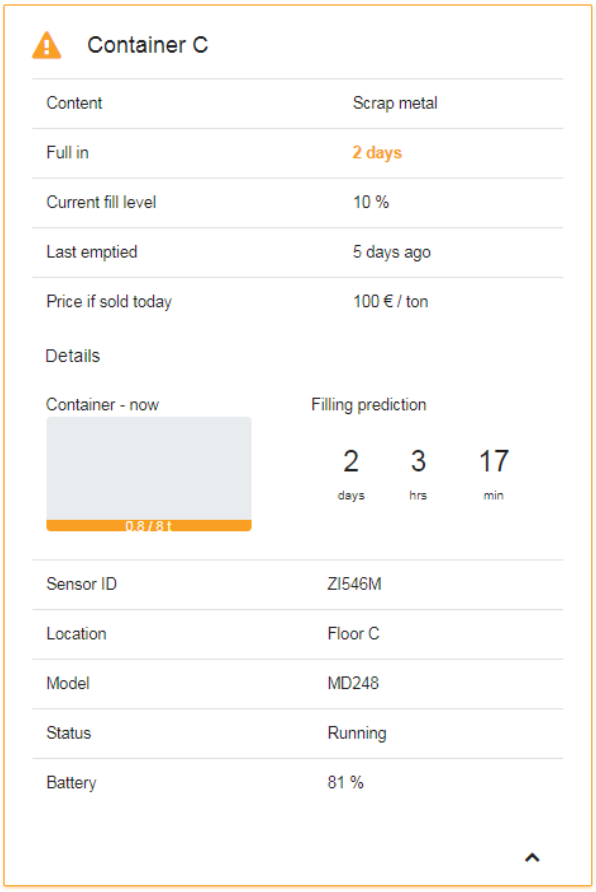


Figure 15: Details of container fill level and its prediction

HMIs for Bidding Process

The bidding process itself has to be represented for different states in the user interface, which are listed in Table 3.

Table 3: List of possible statuses of a bidding process

Step	Status shown to requester	Status shown to supplier	Description
1	Bidding process starts soon	Bidding process starts soon	System prepared the bidding process based on the fill level, estimated amount and predefined settings.
2	Bidding process initialized	Bidding process initialized	Bidding is allowed now.
3	Candidates selection	Waiting for requester to select contractor	Bidding ended. Requester has to choose the contractor.
4	Waiting for contractor to accept	Offer has been accepted/ No deal reached	Requester has to wait for contractor to confirm the contract. Supplier has to confirm in order to start auto negotiation for pick-up date/time.
5	Pick-up arranged	Pick-up arranged	Pick-up is scheduled.
6	Pick-up process completed	Pick-up process completed	Pick-up is completed. Bidding process is completed.

The mock-up for the bidding process was also implemented by CNet. Figure 16 shows a screenshot of the current state of the implementation. The menu is not yet implemented for the marketplace HMIs. This implementation was used for the HMI evaluation conducted at Kleemann in June 2018.

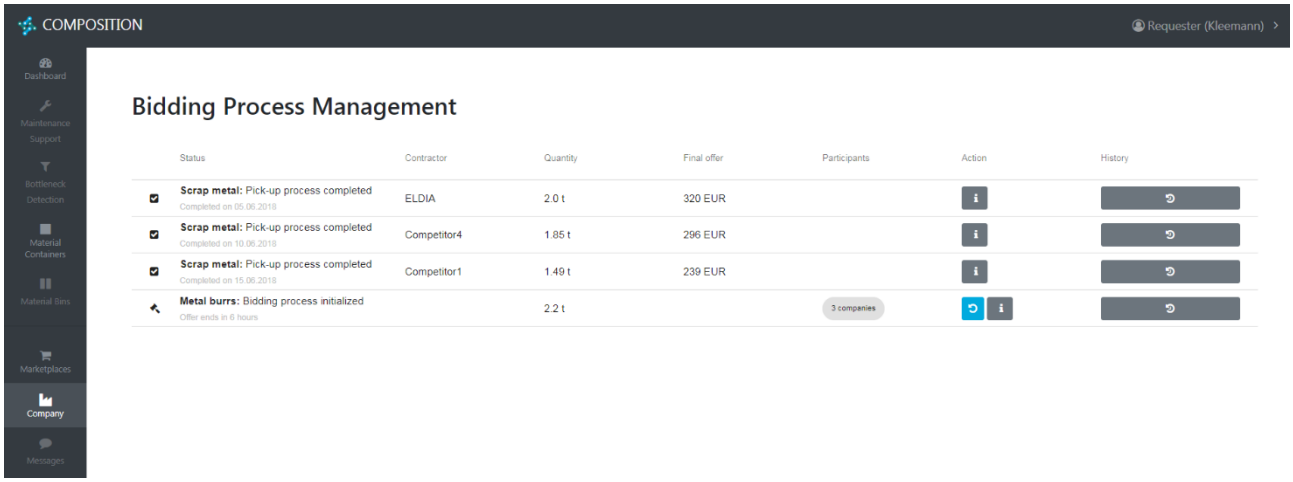


Figure 16: Screenshot of the Bidding Process Management HMI

The layout of bidding process interfaces is the same for all marketplace participants (requester and supplier). Figure 16 is an example showing the view of a requester who has three completed bids and one that will start in 16 hours. Depending on the role (requester/ supplier) and the current state of a bidding process, the user can take different actions and sees properly adjusted text.

Users' feedback gathered in the evaluation was good. The interface will help them to fulfil their tasks in a more efficient way. Anyway, they requested some changes for visual elements and more information in specific steps. Changes that have to be applied in order to improve the utility of the interfaces are listed below. Some changes were discovered or derived by the evaluation sessions, whereas others were already known but not yet implemented for the evaluation (e.g. filter option for completed processes).

(1) List shall be sortable by column.
→ This feature is already planned to be implemented. If a user hovers a column title, an appropriate icon (arrow up/down) is shown.

(2) Number of participants in a bidding process shall always be visible (for each state, expect of “bidding starts soon”).

(3) Furthermore, users expected that the number of participants are clickable, showing a list of the participating companies.

(4) The icon of the button  to *withdraw* a bid is misleading.
→ In Section 6 is a set of icons and the purpose when to use it. Buttons etc. will be updated throughout the system accordingly.

(5) User shall be able to filter by status, waste type and contractor.
→ How to include a filter is sketched in Figure 17.

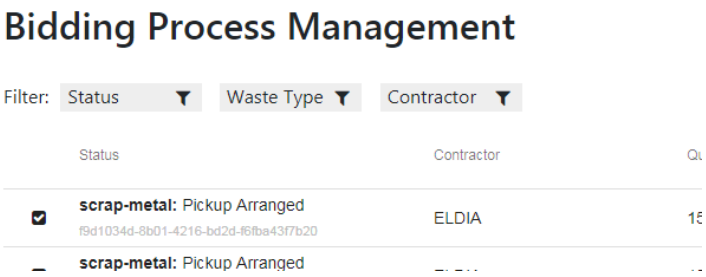


Figure 17: Filter option for the Bidding Process Management

(6) Popups “Information” and “History” should be combined into one, since users were confused where to find which information
→ How the information can be combined into one popup is shown in Figure 18.

(7) By combining the pop-ups, there is more space on the page, allowing the font size to be increased. This was noted in the evaluation as too small.

(8) User wants easy access more information on contractor’s rating.
→ Seeing stars for rating of a possible contractor is not enough for users. They want to see single criteria and understand the rating system.

(9) Optional (must be verified with a representative group of potential users):
Send a notification to the requester if a bidder drops out

(10) Optional (must be verified with a representative group of potential users):
List the start and end times of a bidding process.

How to combine popups for bidding process information

The two examples shown in Figure 18 are representing changes applied after the evaluation. In the first/ left example, the status is still bidding process initialized. In the second/ right example, the pick-up is already arranged.

Following adjustments are made compared to the current implementation:

- Rearrangement of information, based on importance mentioned by users in the evaluation (e.g. in “General”, Session Id and Status is exchanged)
- History is included; last columnt “Notification type” is removed (users did not need this information)
- In the history, all states are listed, but coloured light grey and marked with “pending” if status is not reached yet
- Pickup Details are always shown, listed as pending

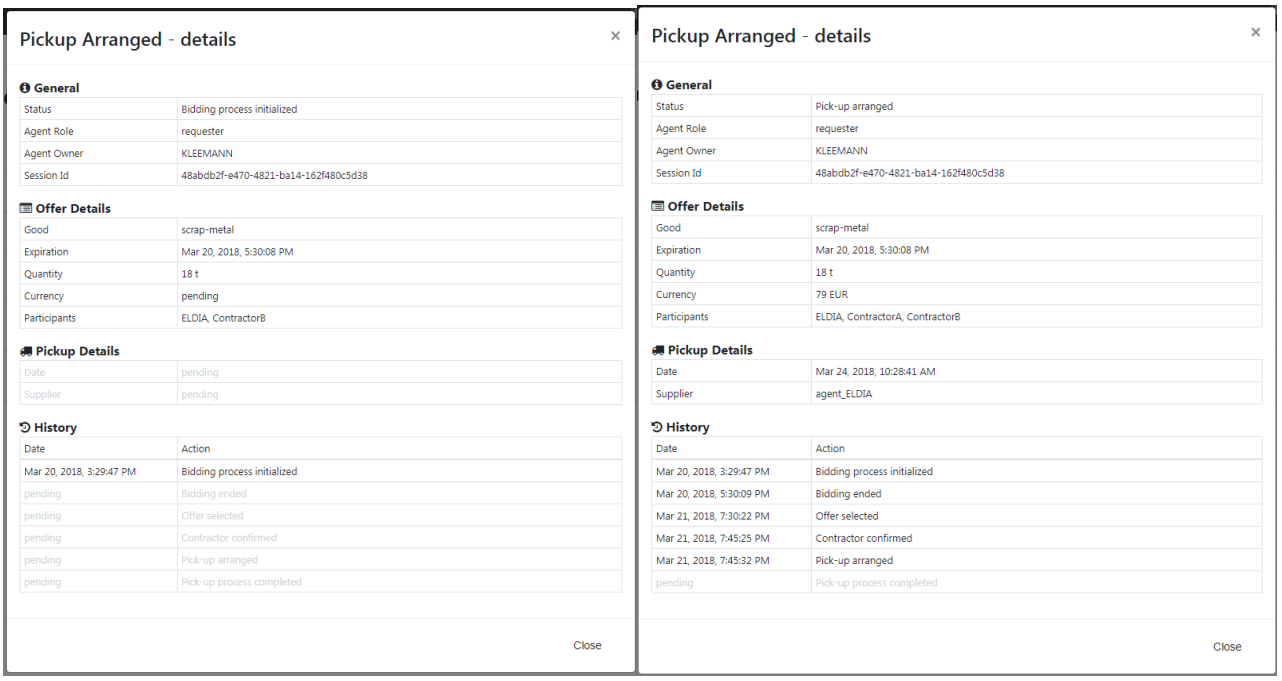


Figure 18: How to combine popups for bidding process information – two examples

Agent configuration view

KLE requires the system to be able to start bidding processes autonomously based on a pre-set configuration. These configurations are set initially when an agent is configured and are not intended for frequent customization. In addition, only specific user roles (e.g. admins) will have access to this view. The configurations include specifications such as:

- Thresholds for the fill level that initiates a bidding process
- Times when a container can be picked up (e.g. only between 10am and 3pm)
- Duration of a bidding
- Access is only given to specific user roles

More information about agents is covered in Section 5.2.5. Required components for the HMI are currently under discussion and sketches are planned for December 2018.

5.2.2 UC- KLE-7 - Supply Chain Management

From the HMI perspective, UC-KLE-4 and UC-KLE-7 are related. While UC-KLE-4 is focused on selling waste by running a bidding process, UC-KLE-7 focuses on buying. However, the HMI design for UC-KLE-7 will rely on UC-KLE-4, since similar elements and steps are required. This was discussed and confirmed by end users during the evaluation sessions conducted in Summer 2018 at KLE.

The HMI for UC-KLE-7 will not be implemented in the scope of this project. The use case will be simulated by software agents only.

5.2.3 UC- ELDIA-1 - Wood and Recyclable Material Management

In meetings with ELDIA it was discovered, that the HMI created for the Container Fill Level Monitoring in UC-KLE-4, targets most of the requirements of UC-ELDIA-1. Compared to KLE, two major differences were identified:

- Containers from ELDIA are located on the premises of other companies
- ELDIA has to monitor more than 100 containers

Both differences can be addressed with only minor changes to the HMIs described in Section 5.2.1. It is assumed that required changes will not have a negative impact on KLE users, which is why the changes will be included in UC-KLE-4, as shown in Figure 19.

The following changes have to be made:

- Add a filter to the top of the page
- Current market prices have to be shown above the containers
- ELDIA has to be able to enter more information to containers, listed within the details section:
    - Contractor/ Customer Name
    - Location of the container
- Container names can easily be adjusted

Furthermore, ELDIA does not need a graph that shows the historical information when containers were emptied.

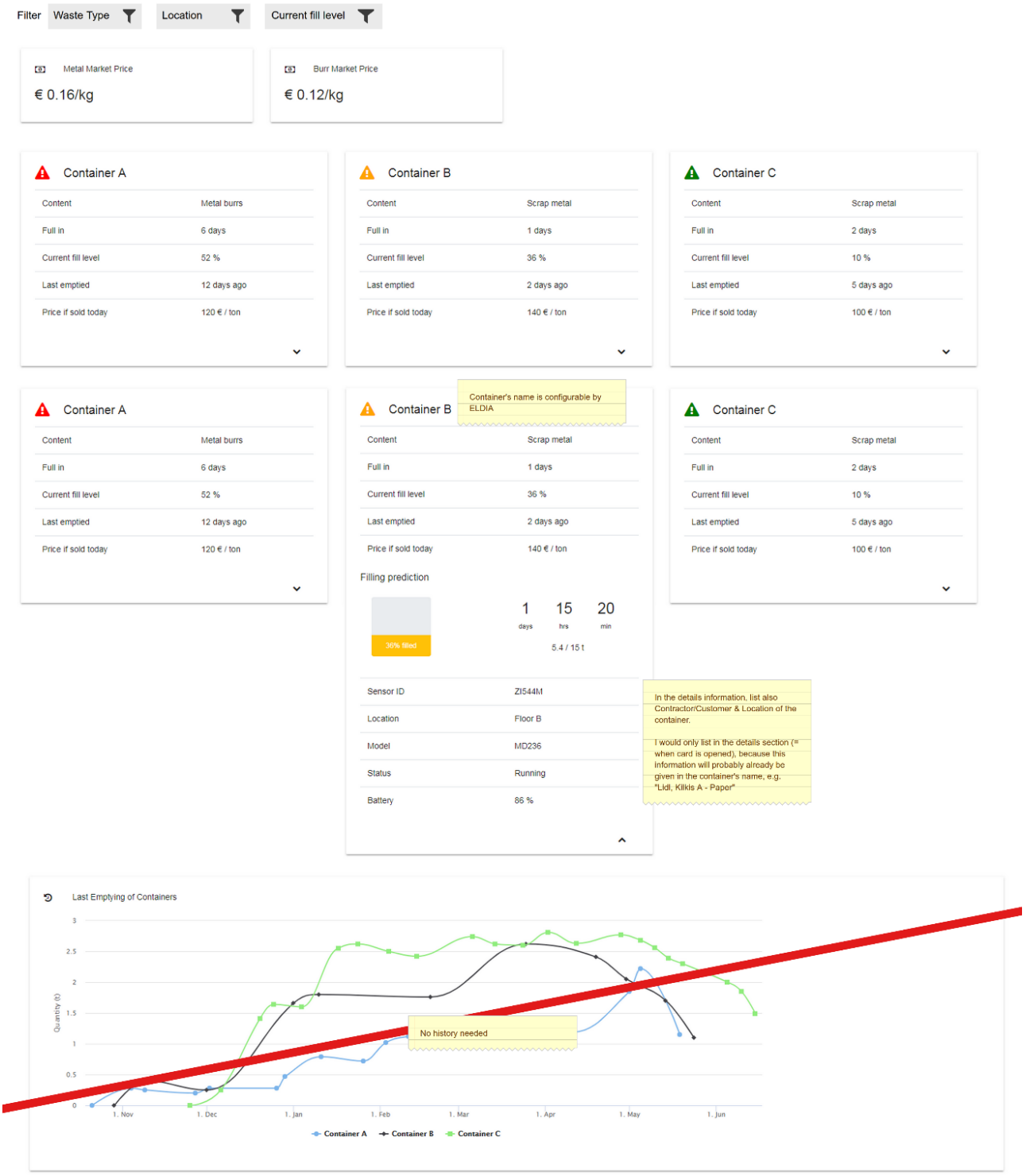


Figure 19: Adjustments that have to be made to UC-KLE-4 to meet ELDIA's needs in UC-ELDIA-1

5.2.4 UC- ATL-1/-2/-3 - Software Distribution

The development of these use cases has not yet started. Only one of them will be implemented, however, it has not yet been finally decided which one will be developed. As soon as the decision has been made, the development of an HMI will start.

5.2.5 Agent Management Portal/ Marketplace Management System HMIs

The Marketplace Management is composed by the Marketplace Management Portal (frontend) and the Marketplace Management Services (backend). The former provides a web-based UI for managing the functionality of the different Marketplaces, whereas the latter empowers the UI functions and allows direct configuration and control of the marketplace event broker.

Marketplace Management components are designed to support many operations that are crucial for the COMPOSITION ecosystem. For example, the Marketplace Management Portal allows stakeholders to join the COMPOSITION marketplaces and to receive the credentials and configuration parameters required by the corresponding agent containers to join. Whenever a new stakeholder joins the COMPOSITION ecosystem, it must be classified by providing some specific information such as personal data, the contracting company, etc. This data is leveraged by the Management Portal to support complex search of available stakeholders, e.g., to conduct preliminary analysis of possible offers and/or possible actors to approach for selling services. Moreover, the same data is propagated to the Matchmaker agent that can take better decisions about possible matches between supply needs and registered suppliers.

To provide these features, the Marketplace Management as a whole implements a set of APIs, that are accessible through RESTful interfaces. The main functionality allows to:

- manage users,
- manage companies,
- manage agents,
- manage agent services.

It follows from that, that the HMI shall be able to support the exchange of all the information needed to handle these features. Therefore, the Portal GUI will be the entry point for stakeholders to manage their profiles and activities on the Marketplace.

A couple of examples, with respect to agent management, are explained below.

Register an agent

A stakeholder wants to register an agent on the marketplace. Through the MMP HMI he/she can trigger the start of a new agent container that:

1. Contacts the AMS in order to receive a unique identifier on the marketplace
2. Receives the *agent_id*, getting ready to start any protocol
3. Gives the *agent_id* back to the Marketplace Management component

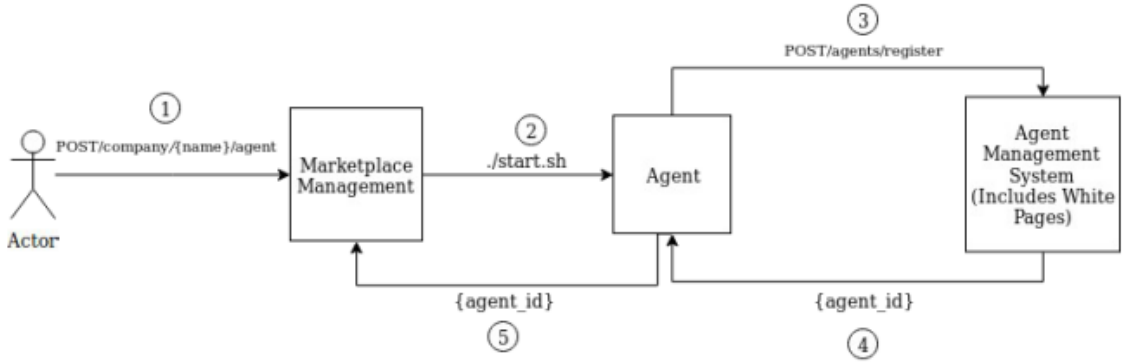


Figure 20 – Agent registration

Un-register an agent

A stakeholder wants to register an agent on the marketplace. Through the MMP HMI he/she can trigger the dedicated API on agent's side:

1. - The agent stops its actions

2. - The agent contacts AMS in order to be also deleted from the Marketplace

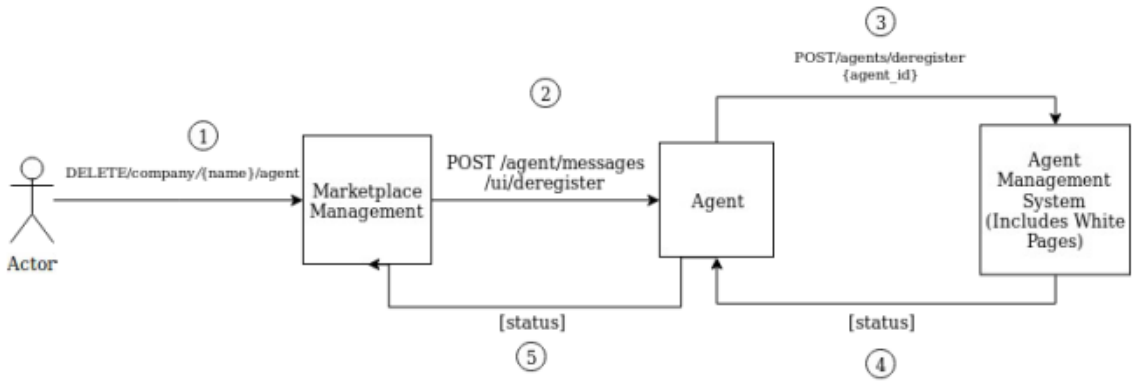


Figure 21 – Agent un-registration

Figure 22 shows the current design of how an agent can be registered on a marketplace. If an agent is registered, it will show up in the list shown in Figure 23 (already introduced in D5.5). This list will provide an option to un-register an agent.

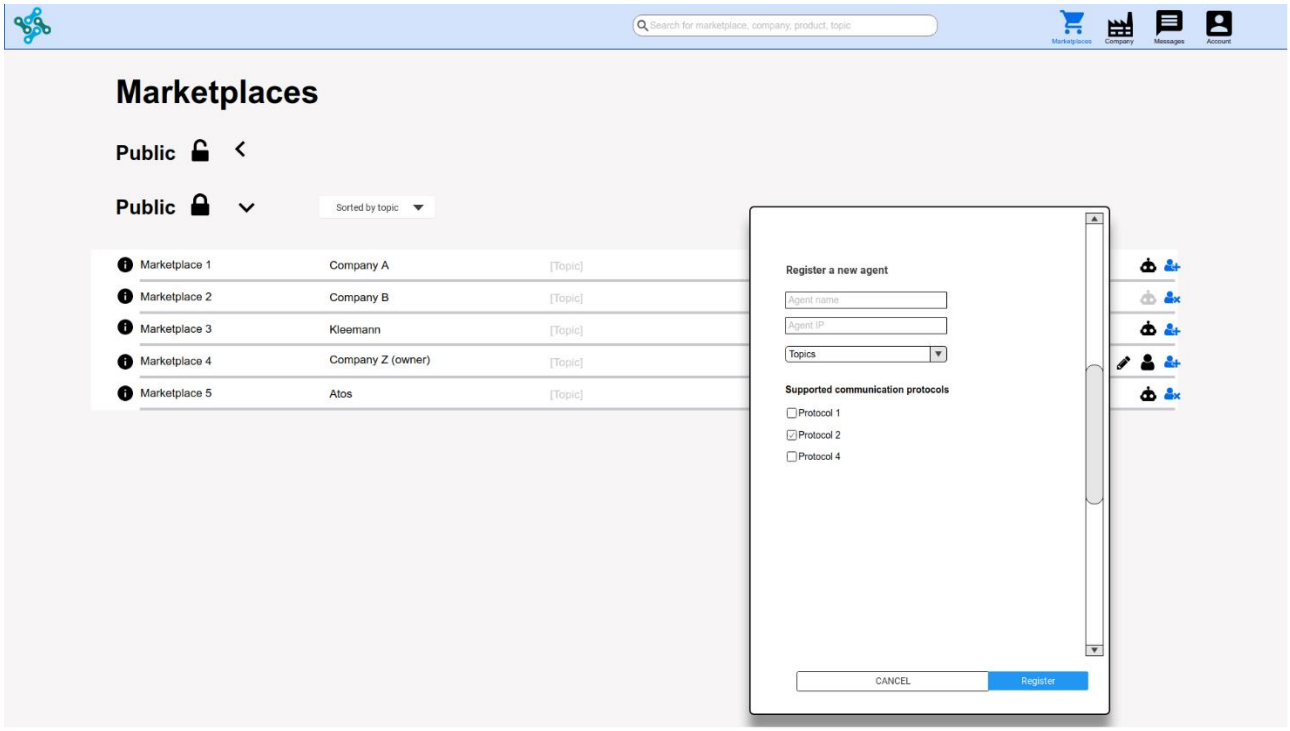


Figure 22: Marketplace Management System - Register an agent

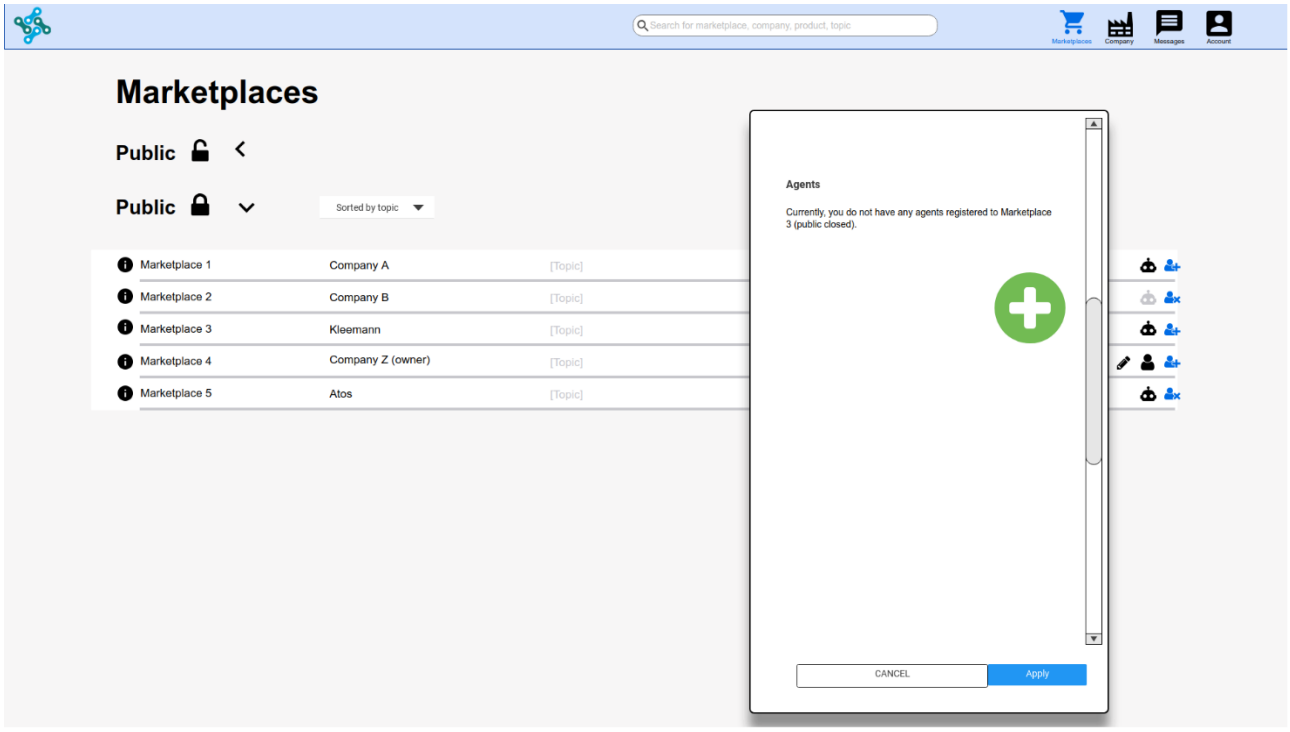


Figure 23: Marketplace Management System – List of registered agents

The implementation of HMIs related to the marketplace will be based on the designs shown before. Figure 24 presents the first implemented screen, which will allow users e.g. to subscribe to marketplaces.

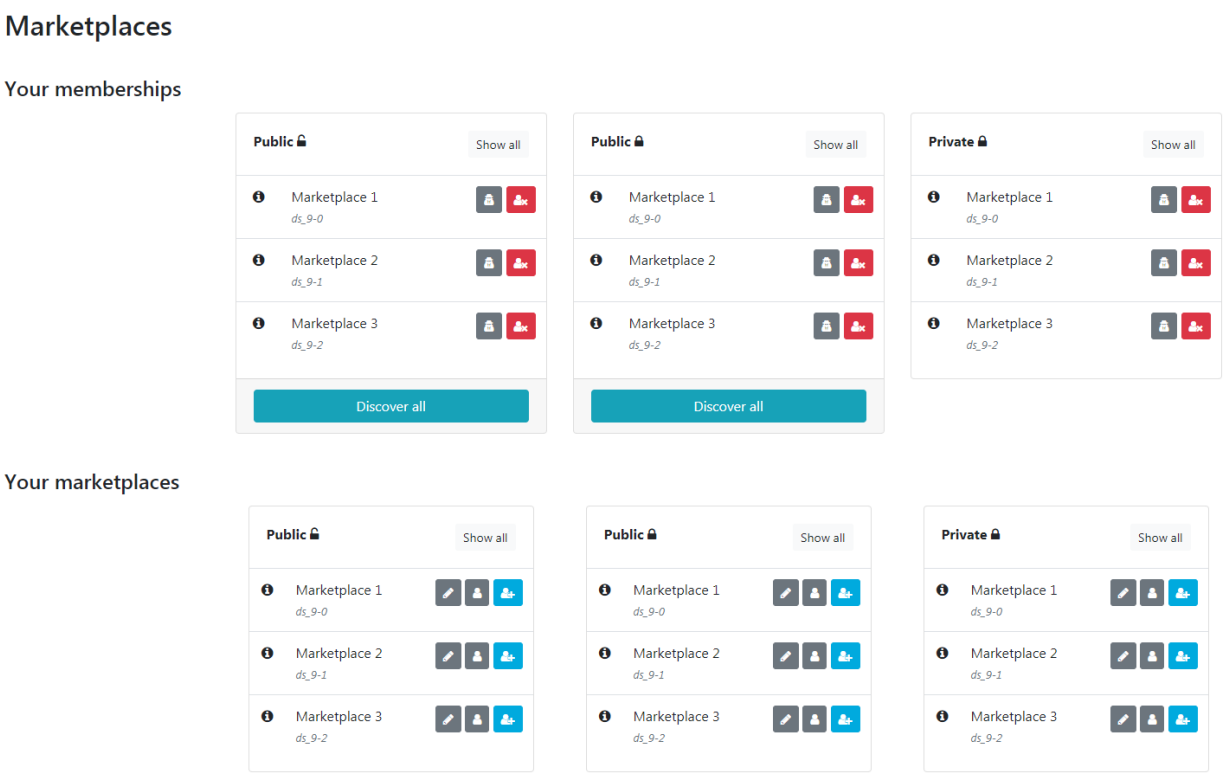


Figure 24: Marketplace Management System – Implementation of Marketplace overview

6 Corporate Design Elements

In order to ensure a common Look and Feel of the COMPOSITION system, it is required that all developing partners follow some design guidelines. This section describes the most important ones.

Frame/Menu

Each HMI, which will be implemented in the scope of COMPOSITION, should be integrated to a common frame (see Figure 25). This frame consists of four parts:

- The COMPOSITION logo
- The menu for the current views that can be accessed (either within “Marketplace” or “Company”)
- The menu to choose between “Marketplace” and “Company” views and message
- The profile of the logged in user, in this example: “Requester (KLEEMANN)”

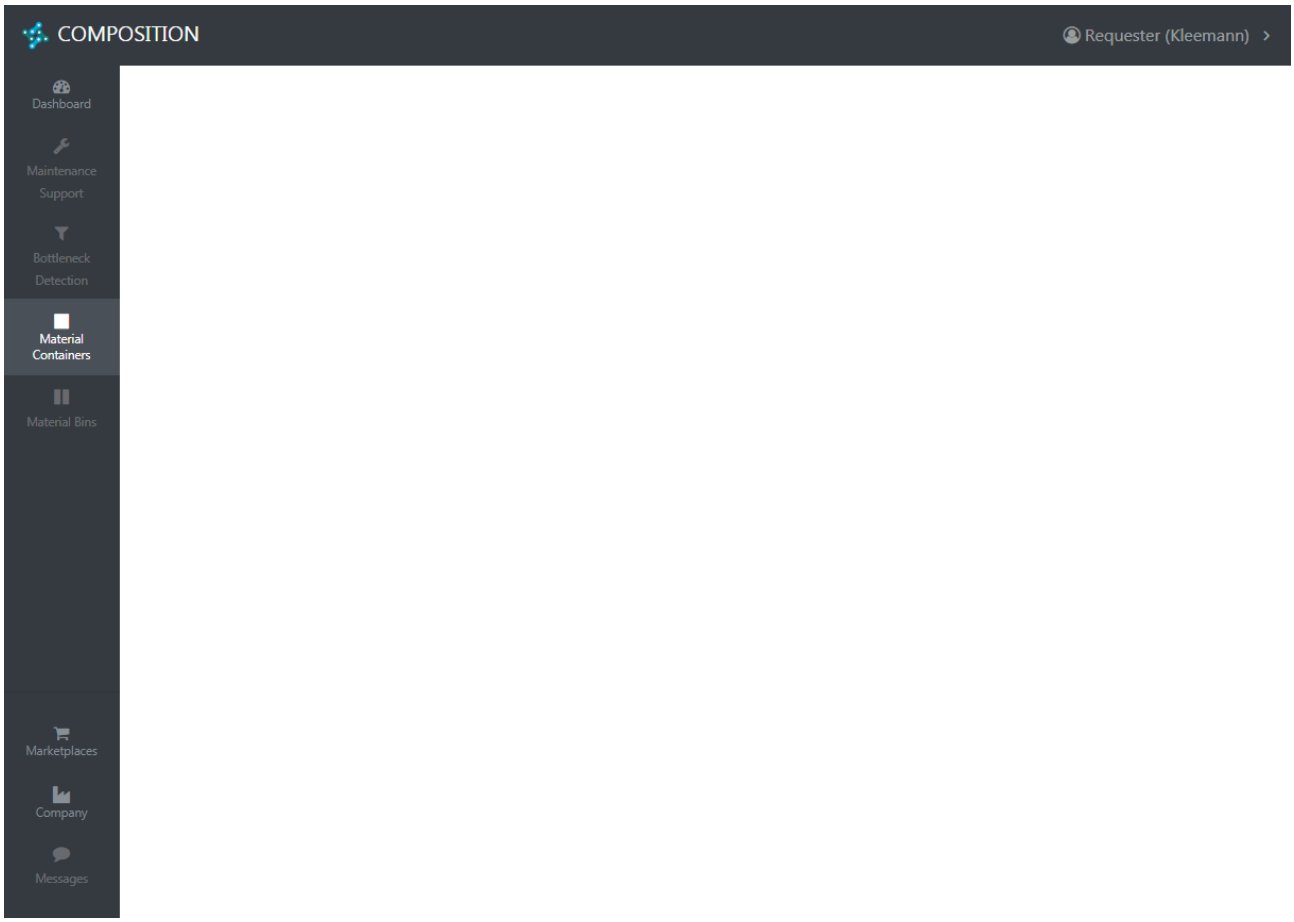


Figure 25: Frame and menu

The structure of the frame and menu allows to have a consistence appearance to all companies and their required user roles. It is easy to hide menu items if they shouldn’t be seen by a specific user role. Which menu items are required for which of the pilot partners, is illustrated in the Appendix 10.2. The frame/ menu shall allow an easy adoption to other companies or scenarios that might be included in a future development of COMPOSITION.

The implementation shown above, presents the first iteration. Currently, the second iteration gets developed as a compact menu, i.e. second level views (e.g. Maintenance Support) can be extended in order to make third level views as KPIs or Rule Engine accessible.

States – Colours and Icons

In some views, users will react based on colour code as they might indicate (upcoming) failures. Therefore, colour codes should always have the same meaning throughout the system. Therefore, the following definitions have been developed (documented in Confluence):

State	Color HEX & descr.		Icon	Font Awesome class (v4.7.0)
Alert	#fe3000	red		fa fa-exclamation-triangle
Warning	#ffa500	orange		fa fa-exclamation-triangle
Normal	#008000	green		fa fa-check

Figure 26: Colour codes and their meanings

Important note: Colours and icons (also similar ones) must not be used for other purposes!

Buttons

During the evaluation sessions in Summer 2018, an inconsistency of the design of buttons was discovered. As a result, rules have been defined for general buttons and specific buttons, that are used more often throughout the system (e.g. filter option).

For a general button, following rules have to be applied:

- Border-radius between 0.18rem and 0.2rem
- Buttons that are next to each other have to be consistent regarding the way to describe their functionality. Either they have:
    - icon and text,
    - only text or
    - only icon.

Examples for general buttons and what is allowed, is shown in the following:

- Not allowed:

- Allowed:

The following screenshot provides a list of buttons that are used more often throughout the system. To ensure that users can easily understand and therefore efficiently work with the system, the following rules have to applied for specific buttons:

Action	Color: Background		Color: Text & Icon		Icon	Font Awesome class (v4.7.0)
Show information	#6c757d	dark grey	#fff	white		fa fa-info
Show history	#6c757d	dark grey	#fff	white		fa fa-history
Cancel sth./ withdraw	#fff border: #ffa500	white; border: orange	#ffa500	orange		fa fa-times
Confirm sth.	#00aade	blue	#fff	white		fa fa-check-square-o fa fa-check
Sortable table column	-	transparent	tbd	black?/ grey?		fa fa-arrow-up fa fa-arrow-down
Filter sth.	-	transparent	tbd	black		fa fa-filter

Figure 27: Definition of specific buttons and their functionality

7 Conclusion

The work presented in this deliverable is part of WP5 Task T5.3 Advanced Human-Machine-Interfaces for Direct Interaction with Real-World Objects. The current status and initial or updated interface drafts of different fidelity levels were presented for all intra-factory and inter-factory use cases. As the project evolved, use cases were revised or decided to not be continued.

The HMIs are designed individually for COMPOSITION and its identified users and are as such outside the state of the art. The applied user-centred approach ensures that the interfaces will fit the user needs and can be used effectively and efficiently for their daily tasks.

The achieved knowledge from task T5.3 will further on influence the D2.6 Lessons Learned and updated requirements report II. Besides that, the interfaces drafted will be implemented or updated based on the evaluation results and will therefore influence the outstanding deliverables of WP8. Insights of users gathered during the project influences the exploitation of given data and therefore deliverable D3.9 Manufacturing Decision Support System II. Furthermore, the development of the Agent Management Portal and Marketplace Management System is applied in WP6 and will be documented in D6.4 COMPOSITION Marketplace II.

8 List of Figures and Tables

8.1 Figures

8.2 Tables

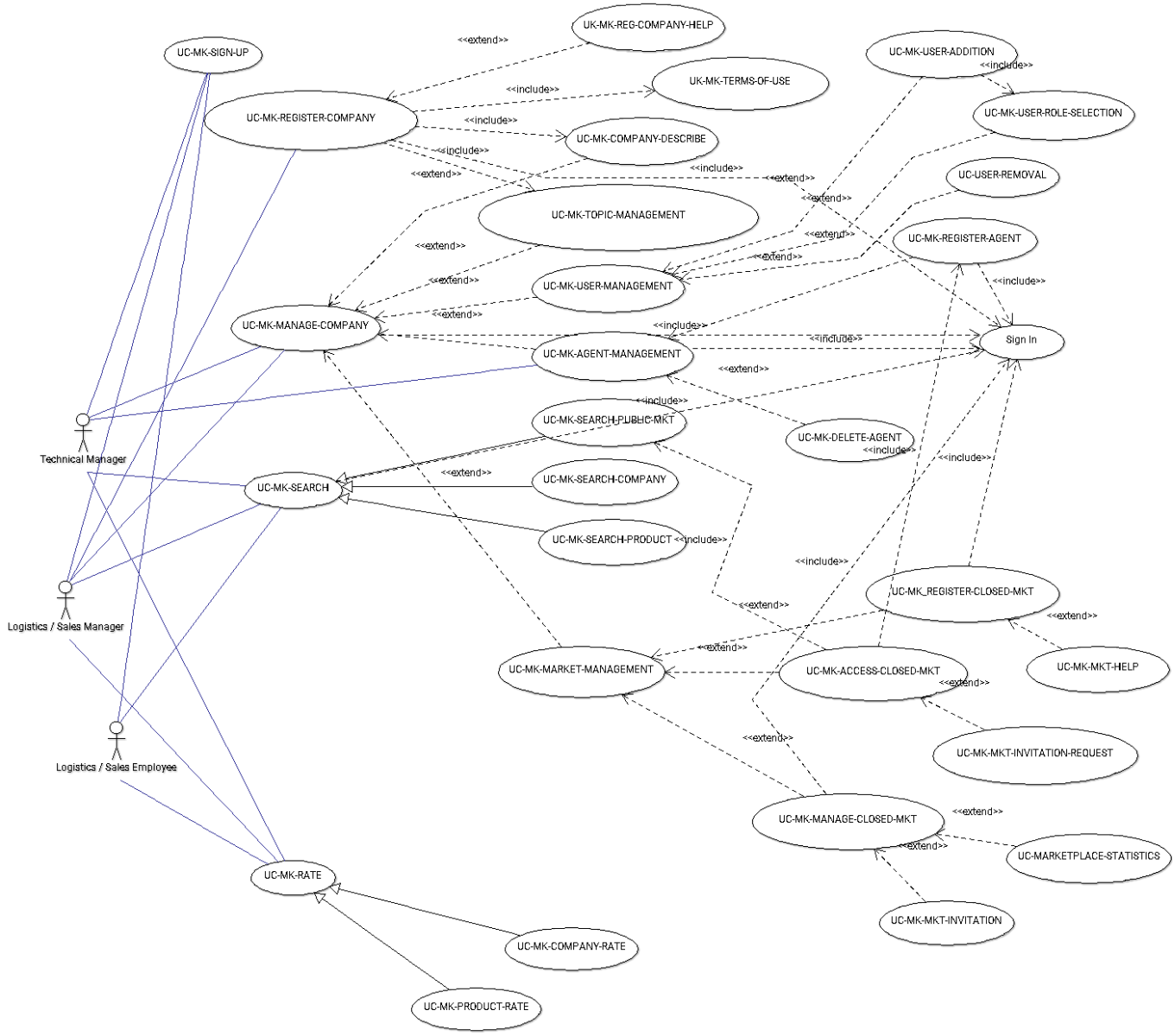
9 References

(International Organization for Standardization, 2010) International Organization for Standardization, "ISO 9241-210:2010 Ergonomics of human-system interaction -- Part 210: Human-centred design for interactive systems," 3 2010. [Online]. Available: https://www.iso.org/standard/52075.html.

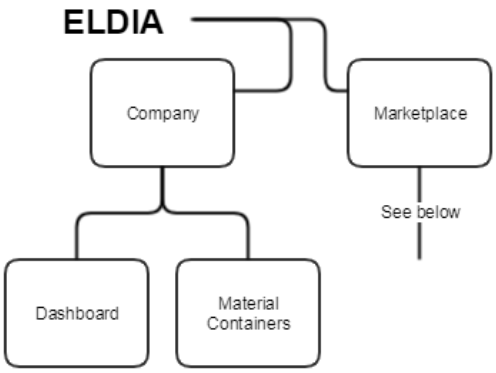
10 Appendix

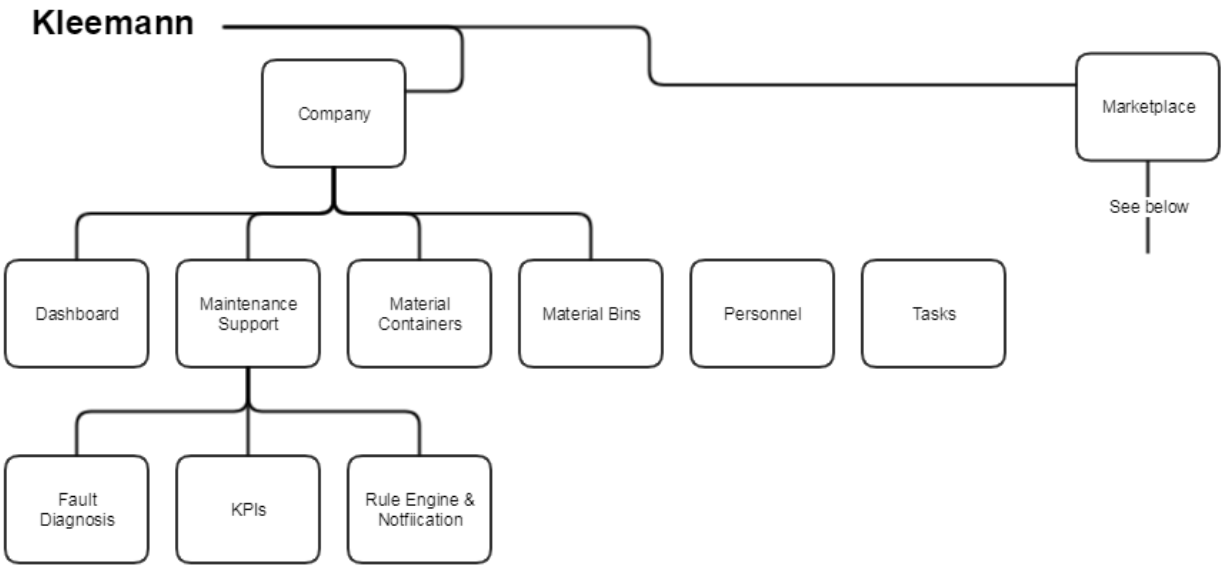
10.1 Functionality map of the marketplace system

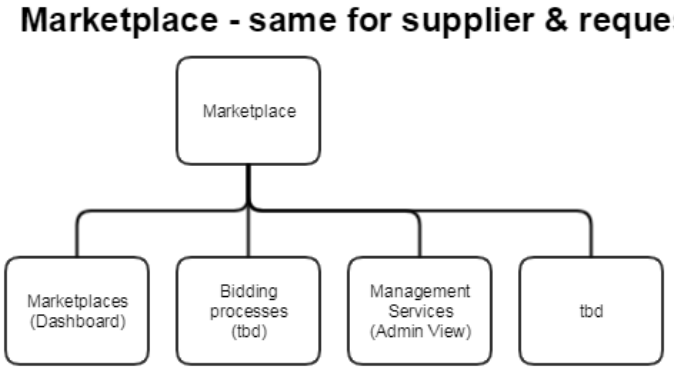
This map was already described in D5.5, section 6.1: “the market place system itself offers a huge set of interaction. Administrative tools such as agent management, user administration, offer settings, etc., allow users to manage their own company’s presence on the system. Additionally, users can register on market places from other companies and receive notifications concerning new offers, bidding processes, contractual information or market place invitations. A rating system is planned to be included to allow for the rating of companies and their offers. A black- or whitelist which can be set up by company administrators with corresponding rights ensures that the automated process of matchmaking will always take the best rated companies into account. A search functionality enables to easily find products or market places.”

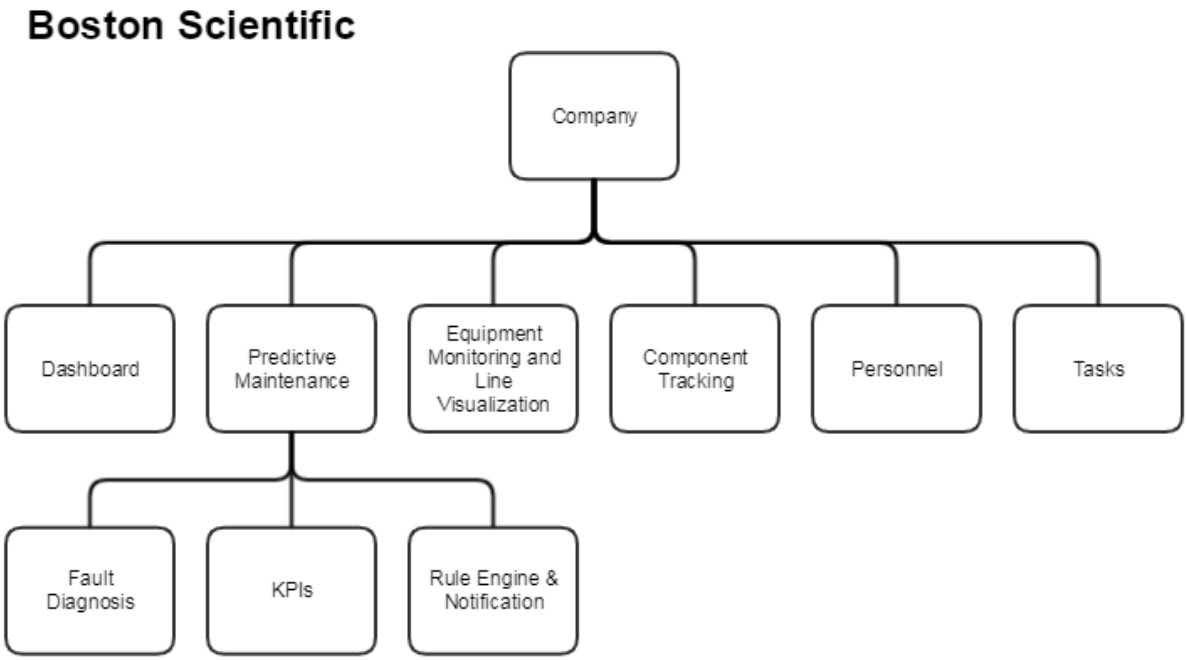


10.2 Menu structure per pilot partner








Boston Scientific
Company
Dashboard
Predictive Maintenance
Equipment Monitoring and Line Visualization
Component Tracking
Personnel
Tasks
Fault Diagnosis
KPIs
Rule Engine & Notification