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TABLE OF CONTENTS

List of Figures *8*

Acronyms *10*

Executive Summary *11*

1. Introduction *12*

1.1 Objectives of the Deliverable **12**

1.2 The Methodology and Taxonomy **12**

1.3 Structure of the Deliverable **14**

2. The I3D approach *16*

2.1 I3D Architecture **16**

2.2 Development environment **16**

2.2.1 Mobile application 17

2.2.2 Back-end, webservice and web-based UI 17

2.2.3 ETL and Automatization component 17

2.3 I3D Terminology **17**

2.3.1 Workflow 17

2.3.2 Step 19

2.3.3 Action 19

2.3.4 Events 20

2.3.5 Preconditions 20
2.3.6 Resources 23
2.3.7 Locations 23
2.3.8 Hotspots 24
2.3.9 Work order 25
2.3.10 Providers 25
3. Description of the Application for on-site support of the workers 27
3.1 Supported HW 27
3.2 Key features of the application 28
3.2.1 User management and related functions, customization 28
3.2.2 User-customization options 30
3.2.3 Overview of assigned Work orders – list of tasks 30
3.2.4 Work order execution and Task level reporting and evidence 32
3.3 Back-end 38
3.3.1 Workflow management 38
3.3.2 Digital twin (work order) creation 40
3.3.3 Digital twin monitoring and management 41
3.3.4 Digital twin Process log 42
4. Integration with BIMERR Tools 45
4.1 Integration with Workflow execution engine (D6.6) 45

4.2 Integration with modeling tools....45

4.3 Integration with BIF and BIM Management platform....45

4.4 Integration with App for residents....46

4.5 Integration with Monitoring tool....46

5. Catalogue of Tools....47

5.1 Workflow execution engine (D6.6)....47

5.2 Smart glass application for on-site renovation worker support....47

6. Conclusions and Outlook....49

References....50

LIST OF FIGURES

Figure 1 PWMA service overview 13

Figure 2 I3D Data structure 14

Figure 3 Architecture of I3D 16

Figure 4 Workflow structure with actions and related events..... 18

Figure 5 Workflow approval procedure to protect work process template against unauthorized changes 19

Figure 6 Example of event 20

Figure 7 Precondition of an action 21

Figure 8 Mathematical and Human readable definition of a precondition 22

Figure 9 Location tree. Root node represented by a 2D picture - a map cut-out ... 24

Figure 10 User management inside the I3D 26

Figure 11 Log-in screen 29

Figure 12 Lock / Log-out / Exit 29

Figure 13 Settings 30

Figure 14 List of assigned tasks (work orders) 31

Figure 15 Details of an assigned task (work order) 31

Figure 16 Manipulation with the task - view the details; start the execution; download to be executed in offline mode..... 32

Figure 17 The start of execution of every task is confirmed by the worker 33

Figure 18 Quick buttons to attach evidence in form of multimedia files are available during the task execution 34

Figure 19 After the execution of a task is finished, the status is set by the worker. Where it is needed, notes and measured values can be attached as well. 35

Figure 20 List of tasks of the work order 35

Figure 21 Statuses of a work order..... 36

Figure 22 Tool set available for the worker in the app for mobile devices 37

Figure 23 Adjustable video recording quality 37

Figure 24 Creation of new workflow with option to load a BPMN file 39

Figure 25 List of work process templates based on the BPMN with same external ID 39

Figure 26 Creation of a workorder - digital twin 40

Figure 27 Empty process log created 41

Figure 28 Visualization of the running work order 42

Figure 29 REST API Output - JSON with a list of work orders created from a selected work process template 43

Figure 30 REST API Output - JSON with process log of the selected work order ... 44

Figure 31 Registration form to become a user of I3D..... 47

Figure 32 App log-in 48

ACRONYMS

Acronym	Meaning
API	Application Programming Interface
App	Application
BIF	BIMERR Interoperability Framework
BIMERR	BIM-based holistic tools for Energy-driven Renovation of existing Residences
BPMN	Business Process Model Notation
ETL	Extract, Transform, Load
H&S	Health & Safety
HW	Hardware
I3D	Industrial 3D services
KPI	Key Performance Indicator
MySQL	Open-source relational database management system
OS	Operating system
PWMA	Process & Workflow Modelling & Automation
px	Pixels
REST	Representational state transfer
SaaS	Software as a Service
SOA	Service Oriented Architecture
SW	Software
UI	User Interface
UX	User experience

EXECUTIVE SUMMARY

This document describes the first version of the Smart glass application for on-site renovation worker support, which we consider as a main tool for workers, project managers and foremen to be used on-site to manage, monitor and report the status of the tasks assigned to this group of stakeholders as part of the whole reconstruction process.

The smart glass application, as well as the workflow execution engine which is utilized to be the backend for the application are developed as part of the PWMA toolkit. The workflow modeled and verified by simulations with other tools of the PWMA toolkit is used by the workflow execution engine to orchestrate the whole reconstruction process, including the management of the on-site works via the smart glass application.

The provided application is part of a standalone toolset based on the I3D platform adjusted for the needs of BIMERR, which provides the set of tools covering the whole life cycle of the management and utilization of the know-how.

In the first version, these main functionalities are covered:

- Overview of the lists of tasks/work orders assigned to the user
- Accessing detailed information about the assigned work orders
- Assistance during execution of the work orders
- Integrated tool for progress reporting
- Support for offline execution

The first version of the application focuses to provide a basic application, which allows basic interactions with the tasks assigned to the user. The next iteration will be deeper integrated to the overall BIMERR ecosystem, especially in terms of utilization of the common Authentication mechanism as well as integrated cooperation with the notification system, which is going to be provided as part of the Deliverable D6.7 “Adaptive workflow management & automation tool 2”.

The functional capabilities are based on the user requirements identified in D3.1 and defined in the corresponding D6.2 “Adaptive Renovation Process & Workflow Models 1” and D6.4 “Renovation Process Simulation Tool 1”. The deliverable at hand therefore explains the technical concepts, the tool functionality of the requested features and provide the Android based application, which can be downloaded at https://i3d.econtent.lu/bimerr/download/.

In parallel to the iteration of D6.2 which improves the way the renovation process management is performed in BIMERR, the follow up proposal of this document D6.9 will correspondingly adapt the tool set to provide better on-site support for workers executing the renovation tasks.

1. INTRODUCTION

1.1 OBJECTIVES OF THE DELIVERABLE

This deliverable provides the first set of Features for Adaptive workflow management & automation

This deliverable corresponds with Deliverables D6.2 “Adaptive Renovation Process & Workflow Models 1” and D6.4 “Renovation Process Simulation Tool 1” and is closely connected to D6.6 “Adaptive workflow management & automation tool 1”. It provides the technological basis in order to perform on-site support for workers. This document therefore focuses on the tools that are provided to enable on-site interaction with the digital twin of the reconstruction process.

Based on the proposal and grant agreement, the target device of the provided application are smart glasses, however, it is not specified, what type of glasses. The initial plan of the consortium to utilize custom built smart glasses developed and provided by one of the former consortium partners has been canceled, what means, that the developers of the SW tools and representatives of the end users are not involved anymore in the process of defining the requirements and designing the glasses (termination of task T5.5).

Other BIMERR applications for smart glasses, like ARIBFA (D5.9 “AI-enabled tools (hardware & software) for in-situ digital building model annotation via smart glasses 1”) are going to use HoloLens’s. This fact raises the need to support these glasses also by the application of on-site support of workers. On the other hand, the application should be prepared to situations, when other type of hardware, such as wearable tablets, smart phones or other different type of hard-hat compatible smart glasses are going to be used. This is the reason, why we have addressed as target device not only the HoloLens smart glasses selected as main wearable device for the project, but also other mobile devices and wearables which we expect, that can be usefully used by workers on-site.

As the back-end for the application for smart glasses, the workflow execution engine based on the I3D platform is going to be used which was initially created as a standalone toolset to define and manage workflow templates, and to manage assignment of tasks for workers wearing smart glasses.

This deliverable introduces the smart glasses application for on-site support of the workers, which is available for the project as builds for several operating systems. The prototype of the demonstrator is available to be used on smart glasses running Android OS or desktops running OS Windows.

The deliverable is closely connected to the D6.6 “Adaptive workflow management & automation tool 1” which acts as a back-end for the application described in this deliverable.

1.2 THE METHODOLOGY AND TAXONOMY

The application for on-site work support is part of the PWMA toolkit (Figure 1), which is intended to be used as the main orchestrator of the reconstruction process. The reconstruction process is designed by

the tools of the PWMA as a workflow and exported in form of BPMN to the workflow execution component. The workflow execution component creates and maintains the Digital twin of the renovation process, including keeping it up-to date to reflect the actual status of the reconstruction process. Where needed, the workflow execution component is used to exchange data with other components outside the PWMA via BIMERR Interoperability Framework (BIF). The workflow execution component orchestrates the mobile application for residents and the app for on-site work support and provides workflow related information to different BIMERR components, including the PWMA Monitoring and evaluation tool.

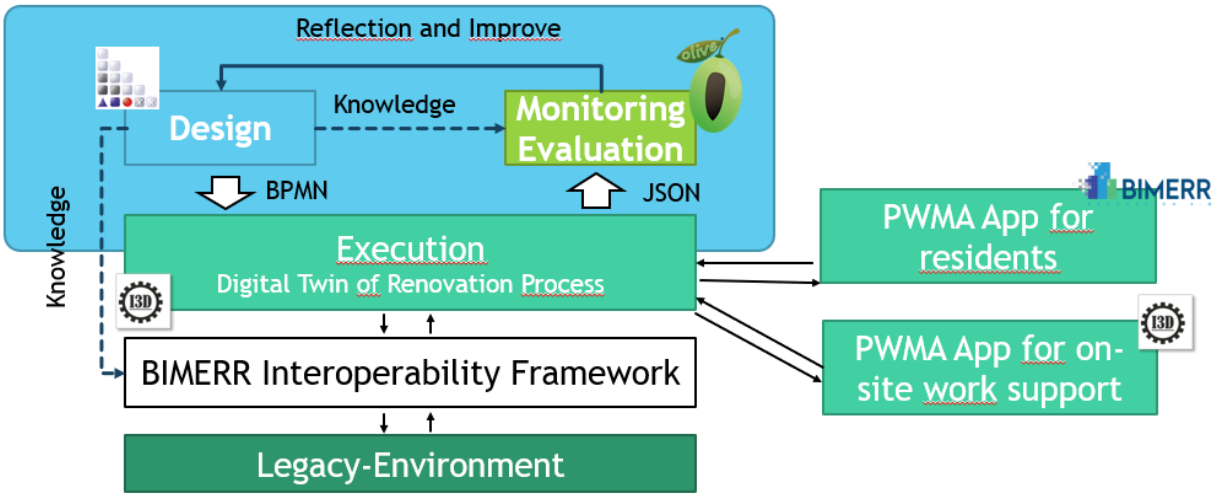

Figure 1 PWMA service overview

The App for on-site work support and the workflow execution component are based on I3D. The already existing I3D solution is an integrated platform of tools and services to support the whole life-cycle of the know-how of a plant or company, from definition of process templates, over issuing task based on the defined templates to execution and reporting. This I3D system is used and adjusted accordingly the BIMERR needs to provide the functionality of executing the workflow and on-site guidance of workers. The basic principles of the I3D system remains, which are:

- Services to define and manage the templates of work processes. This has been extended with functionality to import work processes in form of BPMN file, which has been defined in external systems.
- Services to issue executable work processes based on the templates. Once the process template is defined, it can be used to generate running instances.
- Execution of the work process in semi-automatic way with the options to do user-interactions with the running work process.

- Reports about the work done, including all the data created and collected during the workflow execution.

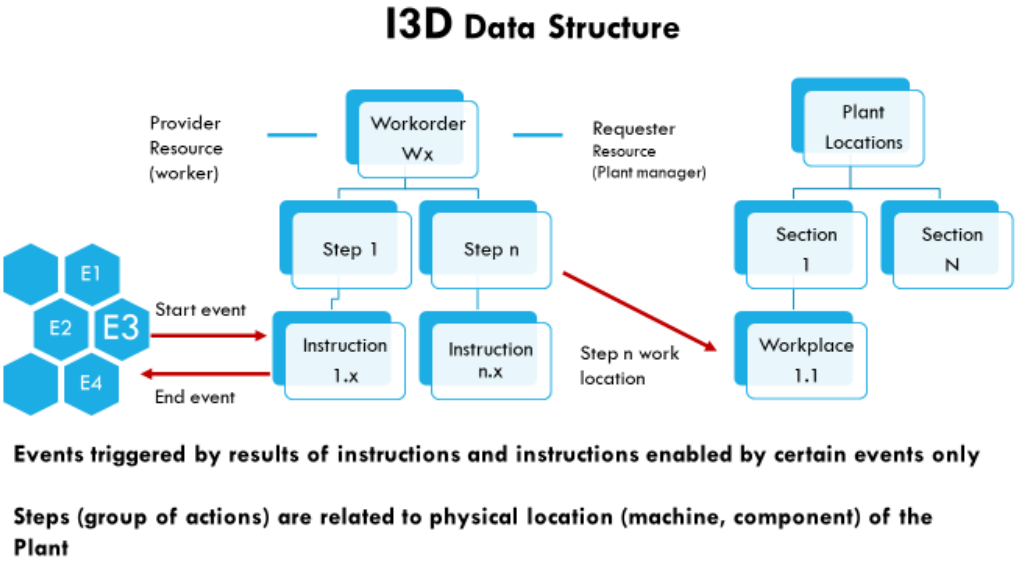

Figure 2 I3D Data structure

The data structure of I3D is displayed on Figure 2.The structure of a work process template (workflow) as well as its executable instance (work order) consists of a set of steps. Every step consists of several instructions (actions). Steps are connected to a workplace. The predefined way of execution of a work process is a sequential execution of every instruction, step-by-step. This sequence can be adjusted with events and preconditions, which are used to skip the execution of any of the actions or to terminate the execution of the work. The taxonomy with more details is described in Chapter 2.2.

1.3 Structure of the Deliverable

The deliverable addresses the aforementioned objectives in form of:

- **Chapter 1** introduces the demonstrator with an overview of the used tool and its functionalities
- **Chapter 2** introduces the background of the developed tool
- **Chapter 3** provides details of the App for on-site support of the workers. In this chapter the key features of the component are described.

- **Chapter 4** provides the details about the integration of the tool with the rest of the BIMERR toolset, in particular with the Adaptive workflow management & automation tool 1 described in Deliverable D6.6.
- **Chapter 5** describes details about how to access and the download locations of the described tools
- **Chapter 6** contains the conclusions and the outlook remarks.

2. THE I3D APPROACH

2.1 I3D ARCHITECTURE

The I3D has been created in accordance with the principles of Service-oriented architecture (SOA). The main building blocks are the (1) MySQL based database, which contains application data. Data of every installation is stored separately; (2) REST API webservice, which is the interface between the database and the tools working with data; (3) ETL tool, which is responsible for importing data from third party systems, including the BPMN file used in BIMERR PWMA toolkit; (4) Web based UI to manage and use the platform; (5) mobile application for on-site support of works, to be used on smart-glasses, mobile phones and tablets.

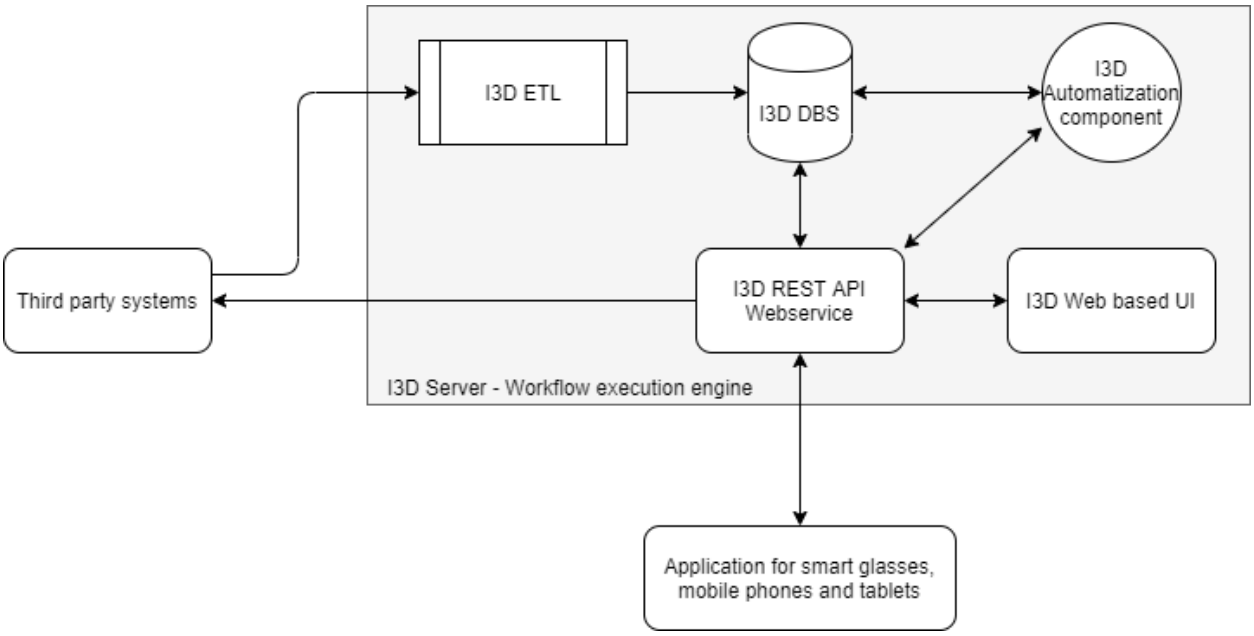

Figure 3 Architecture of I3D

2.2 DEVELOPMENT ENVIRONMENT

The main I3D components displayed on Figure 3 can be divided to 3 categories, which are developed in three main different development environments to provide three type of components – executable application; web based application and server-side application.

2.2.1 Mobile application

The mobile application is developed in Unity3D engine [9]. This environment has been selected because of its wide support of target operating systems, which allows to maintain only one version of the code for several type of HW. The Unity3D engine already provides support for most of the smart glasses already available on the market. Since Unity3D is widely used, also support for glasses to be launched on the market in the future is highly expected. The code itself is written in C# programming language.

2.2.2 Back-end, webservice and web-based UI

The back-end including the webservice has been developed in PHP. The web-based UI is based on AngularJS which combines TypeScript, HTML and CSS with the support of Bootstrap to provide modern responsible UI.

2.2.3 ETL and Automatization component

The ETL tool has been developed in JAVA programming language. It is a server-side application, which is responsible for (1) collecting data from different sources, (2) their transformation to the structure required by the I3D Data structure and Webservice and (3) loading the data to the database. The same programming language has been used to execute planned actions by the Automatization component.

2.3 I3D TERMINOLOGY

Since the workflow execution engine and it's different UIs (web based UI and applications) are based on an existing established complex solution with its own naming which is not always aligned with the naming used in the BIMERR project, it is important to define some key components (workflow, work order, step, action) for better understanding. This subchapter defines the most important components of I3D with examples in form of UI screenshots.

2.3.1 Workflow

In I3D, the term Workflow is used for a work process definition, a template, which contains a step-by-step and action-by-action definition (see Figure 4) of a work process. It defines what action is needed to be performed, at which location and what resources are needed. In case of need, also details about the procedure can be defined in form of step-by-step guidance.

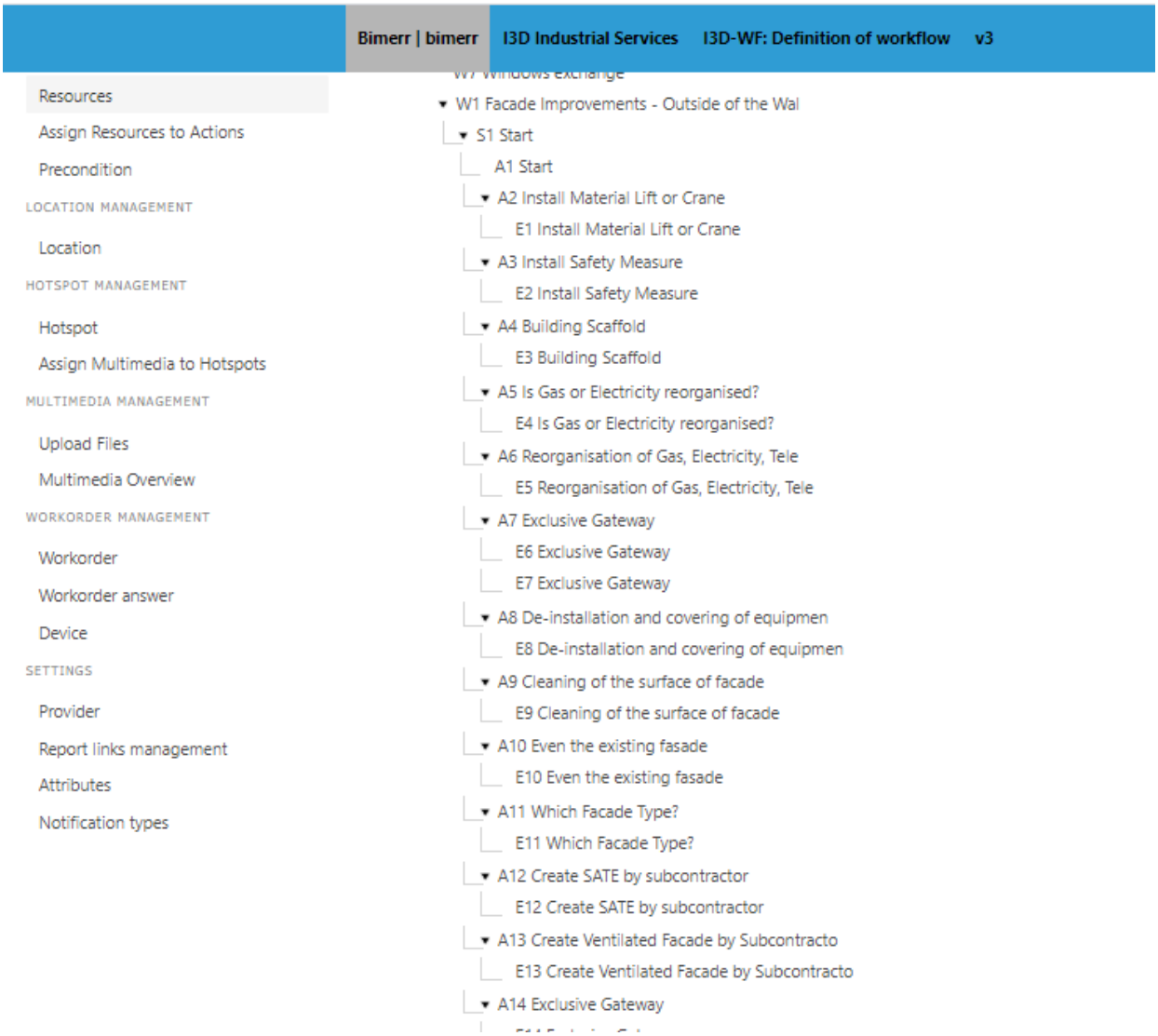

Figure 4 Workflow structure with actions and related events

The workflow can have several states: design phase; approved; expired. The workflow is closed during the approval process and is protected against changes to ensure that no unauthorized changes are done in the work template. Only a protected workflow with valid approval (Figure 5) can be used to generate a running instance – a digital twin of the work process.

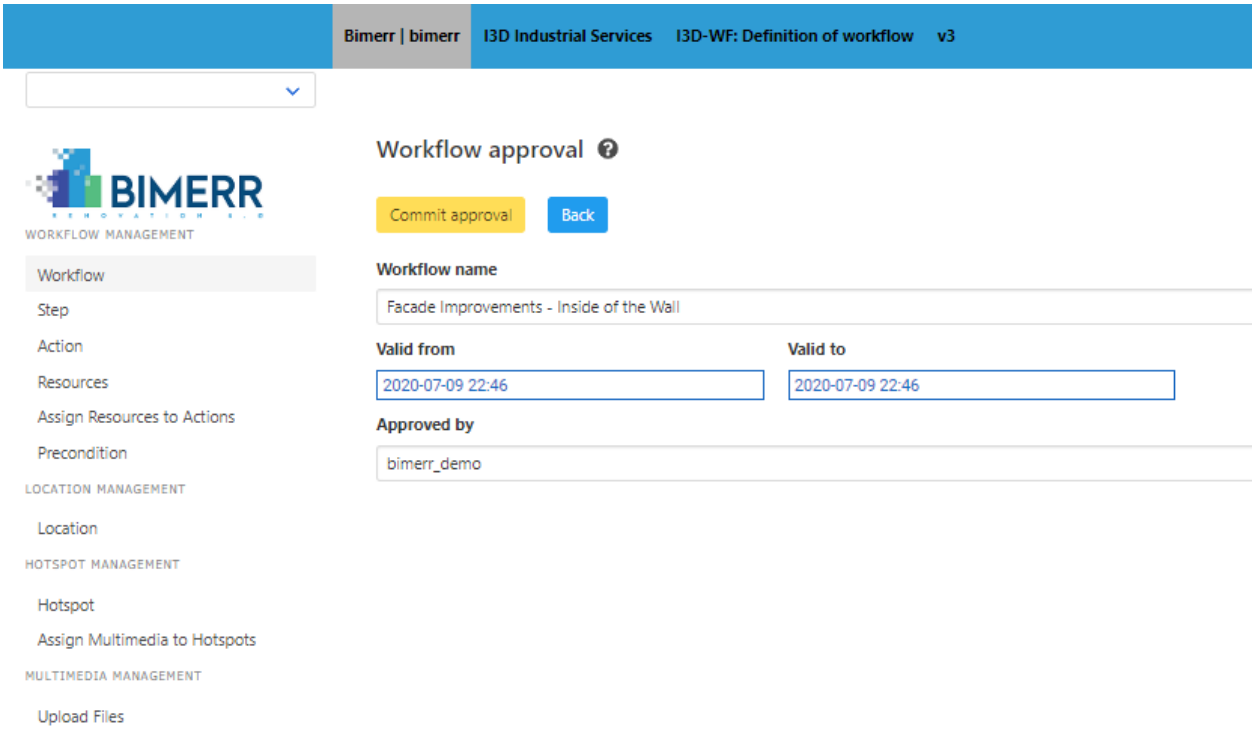

Figure 5 Workflow approval procedure to protect work process template against unauthorized changes

2.3.2 Step

Every workflow consists of one or more steps. Steps are linked to locations. Every step has its own sequence number which defines the sequence of the steps inside the workflow. Every workflow needs to have defined at least one step. Where needed, steps can be used to group actions to be executed at the same place.

2.3.3 Action

Every step consists of one or more actions (instructions), which represent the exact task to be executed by the user. The action has a short name and longer description and a defined expected duration, which indicates the typical time needed to execute the action. The actions can have also defined a unit and minimal and maximal value. If these attributes are filled out, it indicates that the user need to execute some measurement and to record the collected data.

Actions can have also assigned one or more resources, which are expected to be used during the execution of the action. For every action, a list of visible hotspots can be defined, which may help the execution of the action.

Executability of any of the actions can be driven by preconditions and events.

2.3.4 Events

Events are evaluation of the results of previous actions, or data collected via API calls from 3rd party systems. Typically, an event can be e.g. successful execution of an action; measured temperature in defined range; measured pressure out of defined range, etc.

The Figure 6 displays a defined event – in this case, the event "E119 – Crane installed" indicates, that the crane has been successfully installed and is ready to be used.

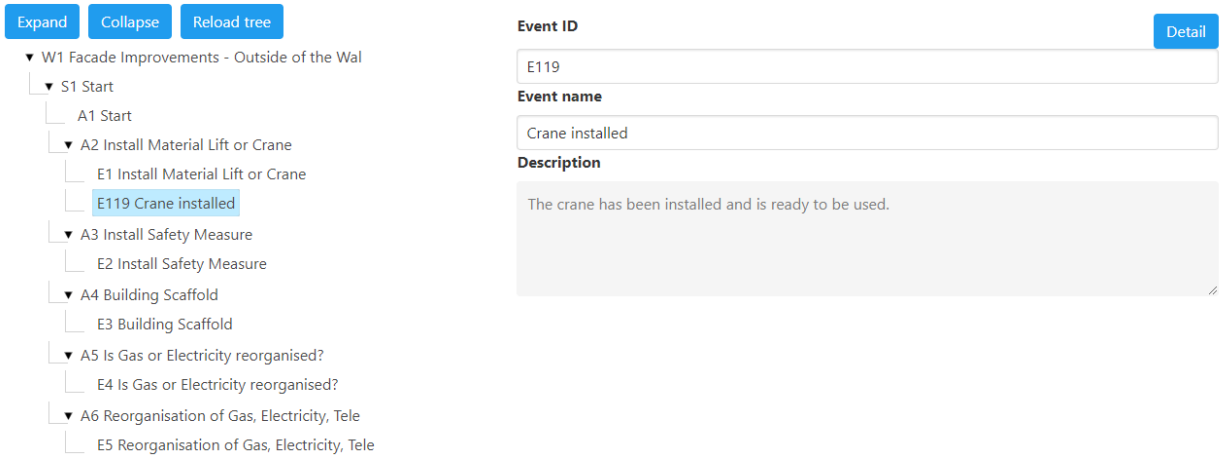

Figure 6 Example of event

2.3.5 Preconditions

Preconditions are mathematically defined rules or formulas, which need to be fulfilled before the action, to which the precondition is assigned, becomes executable (Figure 7). In the definition of preconditions, Events are used, which represents evaluation of the results of previous actions or data collected from third party systems. Every action can have assigned one or more preconditions.

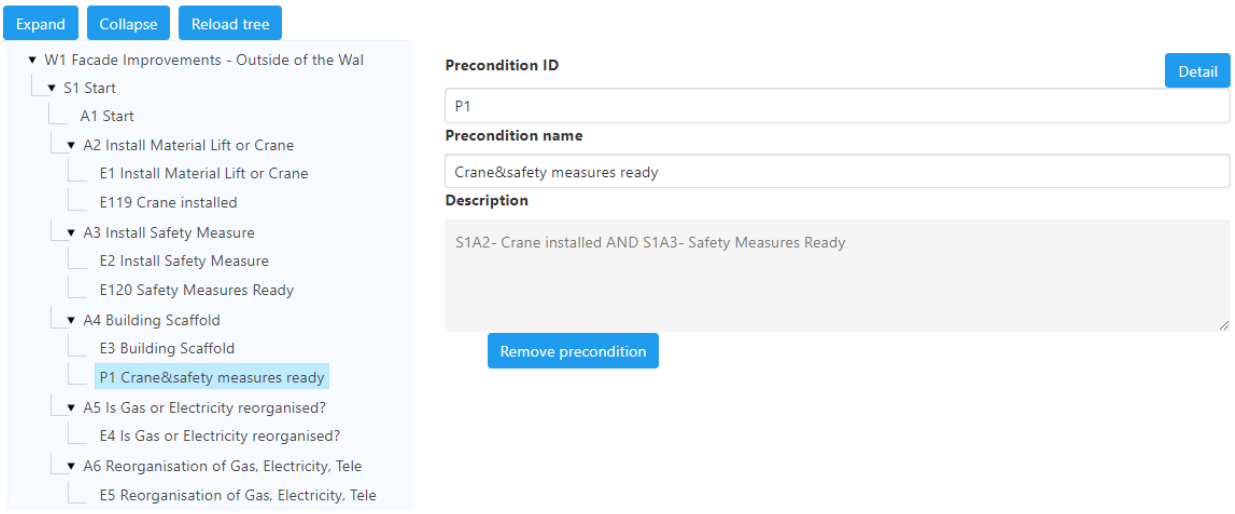

Figure 7 Precondition of an action

Example of definition of preconditions is displayed on Figure 8. On the displayed example, two events must be fulfilled at the same time before the task to build the scaffold is started – the crane must be prepared, and safety measures must be ready.

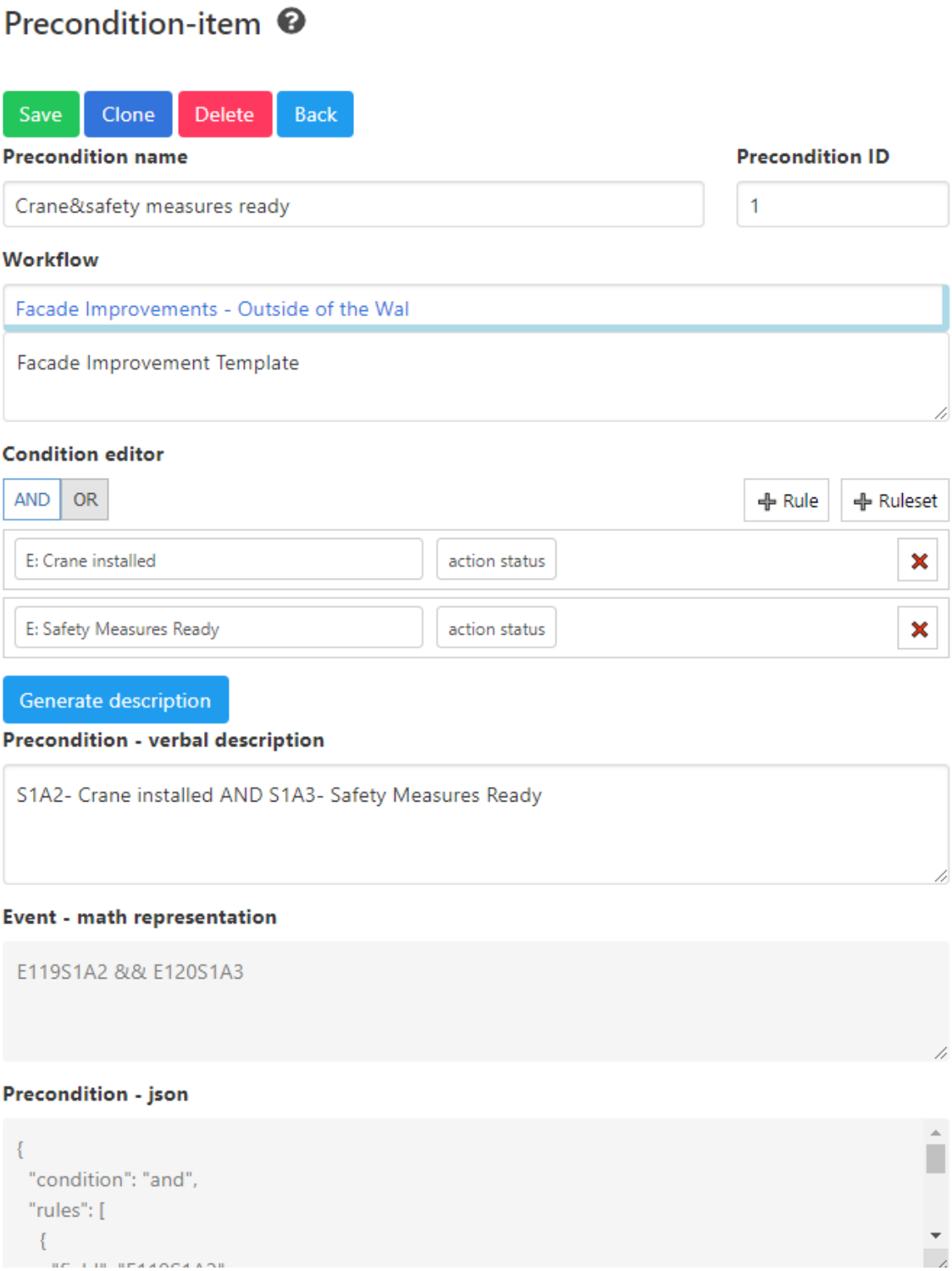

Figure 8 Mathematical and Human readable definition of a precondition

2.3.6 Resources

The system provides tools to define a database of available resources. The system provides the opportunity to assign some resources to any of the actions. A typical resource can be some measurement tool, a crane, or other tools and resources which have limited availability and their usage needs to be planned. Alternatively, resources can be also materials needed for successful execution of a task.

2.3.7 Locations

A separate module of the system is the Location management module, which provides the toolset to define and manage the location hierarchies. By default, three types of locations are distinguished in the system – Plant, Section and Workplace.

Plant is the root node and it defines typically the plant or building, to which the workflow is connected. Sections are the inner nodes – typically a building, a floor or other logical group. Workplaces are the leaf nodes, on which typically the work is going to be executed. On Figure 9, Item with ID 3 – Dormitory is the Plant; Sections are items with ID 4, 5, 6, 7. Workplaces are items with ID 8, 9, 10, 11 and 12.

Every location can be represented by a picture. While the Plant and Sections are typically represented by 2D pictures (map, floorplan, etc.), the Workplaces are typically represented by spherical photos or rendered images.

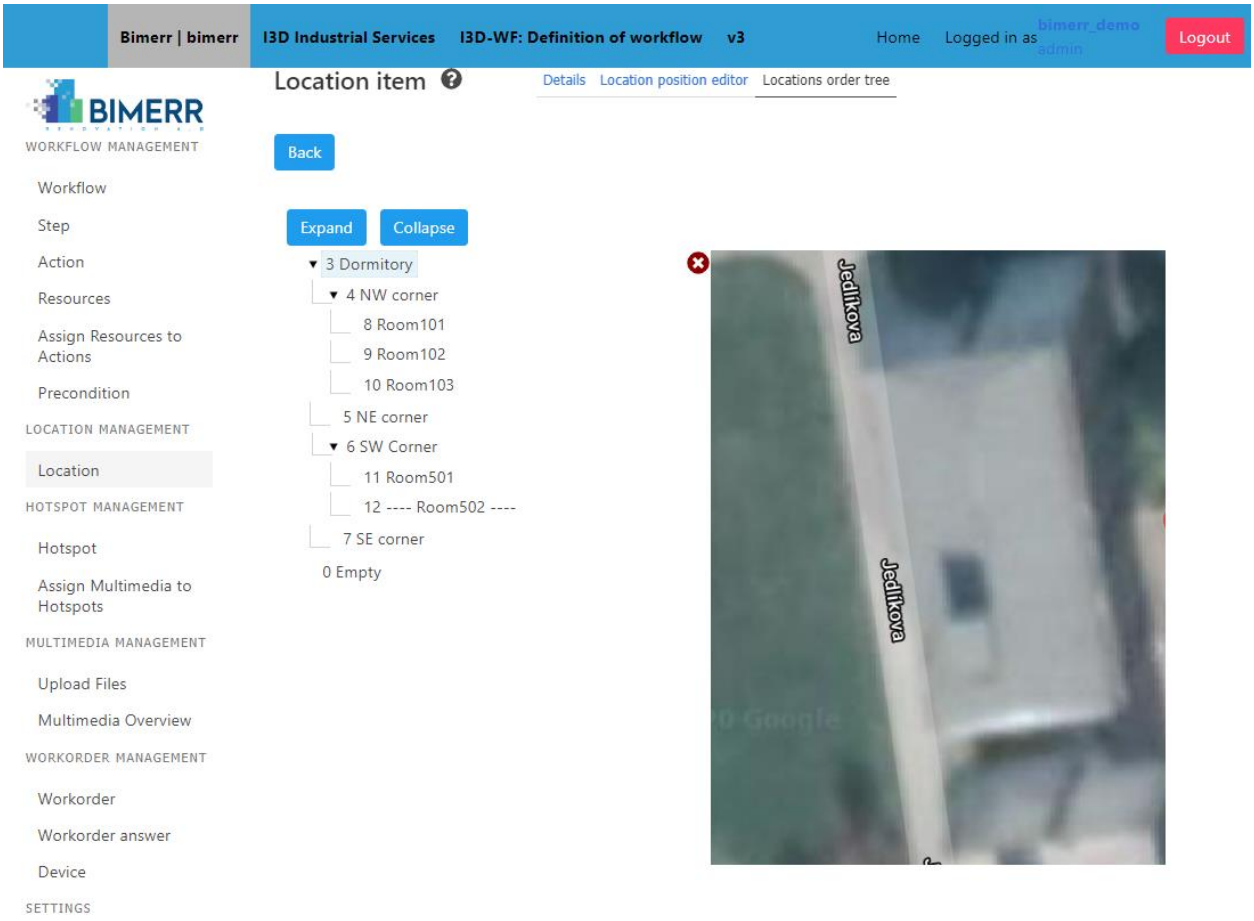

Figure 9 Location tree. Root node represented by a 2D picture - a map cut-out

Every location has defined its GPS coordinates, a short name and description, the location type and link to the prior location – location on higher level in the location's hierarchy. The locations from the BIM model are going to be transformed to this structure by an ETL tool.

2.3.8 Hotspots

Hotspots are digital twins - real-life elements in the virtual space. A hotspot can be a heating element, a switch, a slope, a machine, or any element, which is important enough to have digital representation.

Every hotspot has its definition, which typically consists of name and description and assigned multimedia content (pictures, videos, drawings, animations, etc.). One of the important attributes of every hotspot is its position on every location, where it is recognizable.

2.3.9 Work order

Work order is a real instance, a so-called digital twin of the process generated from the work process template - workflow. It is a real running work order, which is assigned to worker and which needs to be executed at defined time. A running BIMERR reconstruction process is handled as a work order.

2.3.10 Providers

Providers are the users of the system. Every user can have assigned different user roles (Figure 10). Every user role provides a set of permissions for the user that determines the functionalities accessible for the user.

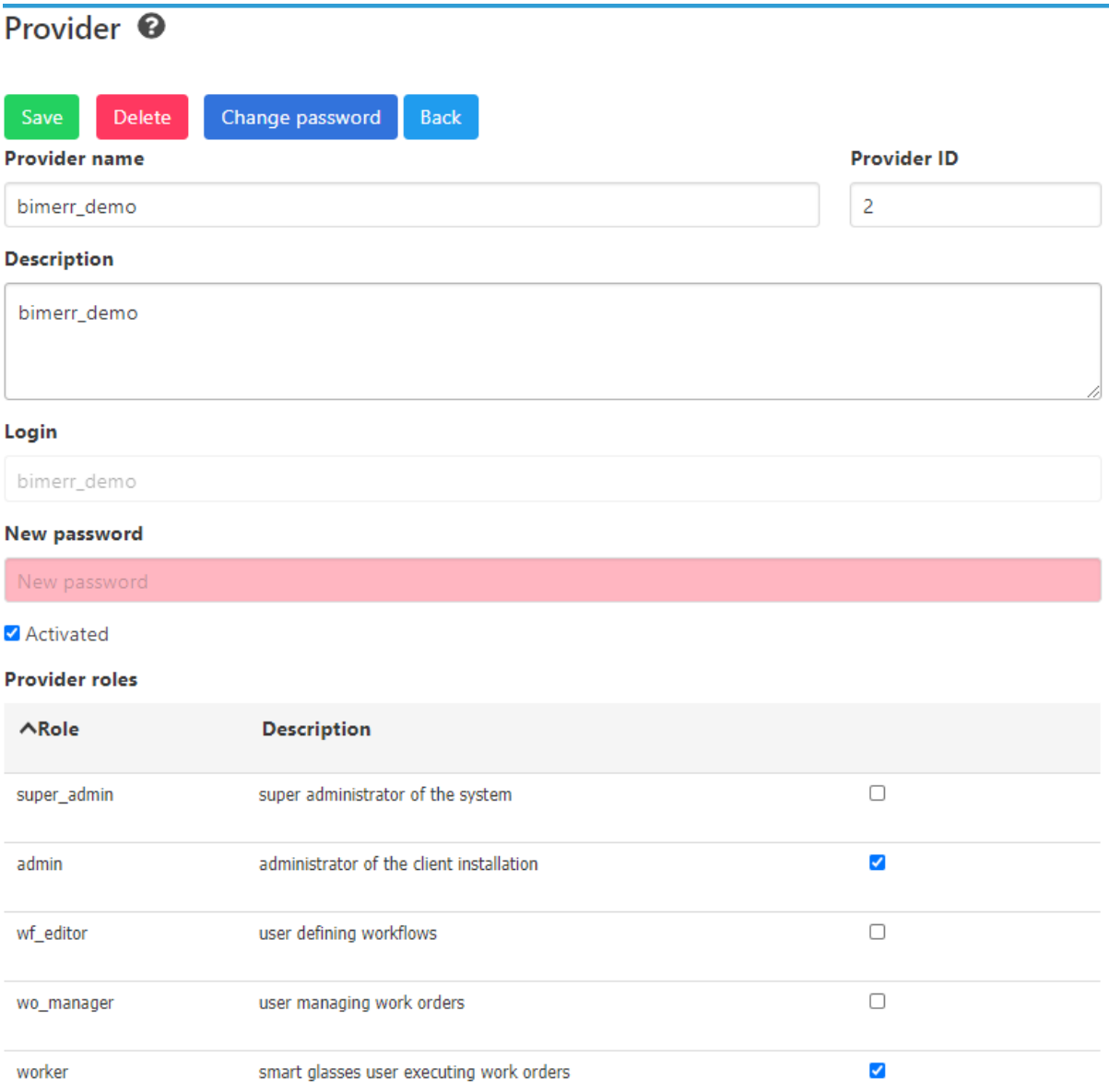

Figure 10 User management inside the I3D

3. DESCRIPTION OF THE APPLICATION FOR ON-SITE SUPPORT OF THE WORKERS

This chapter contains a detailed view on the main features of the smart glasses application for on-site support of the workers. Some overlapping with the Deliverable D6.6 “Adaptive workflow management & automation tool 1” is obvious, since the two components are complementary to each other and the application is de facto an additional UI to the Workflow execution engine focusing on different user groups.

3.1 SUPPORTED HW

The smart glasses application for on-site support of the workers has been developed in Unity3D engine [9], which provides out-of-the-box support for most of the smart glasses already available on the market as well as smart glasses to be launched on the market in the future. The development tool Unity3D has been selected to support as many target devices as possible. This approach allows us to focus more on the features of the SW solution regardless the target OS, on which the application will be used. With little extra effort in the UX design, the support for mobile phones and tablets can be easily achieved, too.

Despite of the HW independency of the SW solution, it is good to have a preferred HW, on which all the functionalities are tested and fine-tuned. For this purpose, we have selected the smart wearable tablet HMT-1 [10], which is a powerful, fully-rugged Android computer that is worn on the head and replaces the touch screen with an articulated micro-display, giving the appearance of a 7-inch tablet screen. On top of it, the application is tuned to utilize the built-in voice recognition feature, which gives the user the opportunity to operate the application and device fully hands-free only by voice commands. Additional features such as hard-hat compatibility, rugged drop and waterproof design and outdoor display makes it a very suitable candidate to be used on construction sites. The selected wearable allows the worker to maintain full situational awareness and maximum productivity.

Besides the preferred device, on which the application is fine-tuned, during the project, the application will be ported to several smart glasses including the MS HoloLens2 [11] as well as the support for use on mobile phones and tablets will be tuned. This will give the opportunity for the end users to select for every task or type of work the appropriate HW device.

The second version of the application is planned to be ported to these smart wearables: Microsoft HoloLens2 [11], ThirdEye Gen X2 [12], Glass enterprise edition 2 by Google [13].

3.2 KEY FEATURES OF THE APPLICATION

The features of the application reflect the user requirements defined in D3.1. The application is designed to support the on-site works of different user groups. The application reflects these main group of requirements:

- Exchange information between different stakeholders (Project Manager, Site Manager, Workers, Occupants, Workers)
- Generate and receive notifications
- Display the list of tasks assigned to the logged-in user
- On-site guidance of workers for critical tasks
- Documentation of the provided work
- Documentation of issues with multimedia
- Operation of the glasses with voice commands and gestures.

3.2.1 User management and related functions, customization

The first screen is the login window, which asks the user to log in with his assigned username and password (Figure 11). At the first use, the user is asked also to enter the Company name, which is the unique identifier of the installation in the system I3D. Once the identifier is entered, the application remembers and preloads it until the application is re-installed or the configuration file is deleted.

After successful authentication, the user is logged in to the application and a set of permissions to access the applications functionalities is granted to the user, based on the groups to which the user belongs. All user groups use the same application, the role of the user determines the tools, which are available for the user.

To avoid unauthorized access to information, the application has an idle counter of 10 minutes, after which the application locks the screen and the user is requested to re-login to further use of the application. The user can lock the screen or to log out from the application intentionally, too (Figure 12).

The application does not provide the functionality to register new users. This option is provided by the back-end – the workflow execution engine.

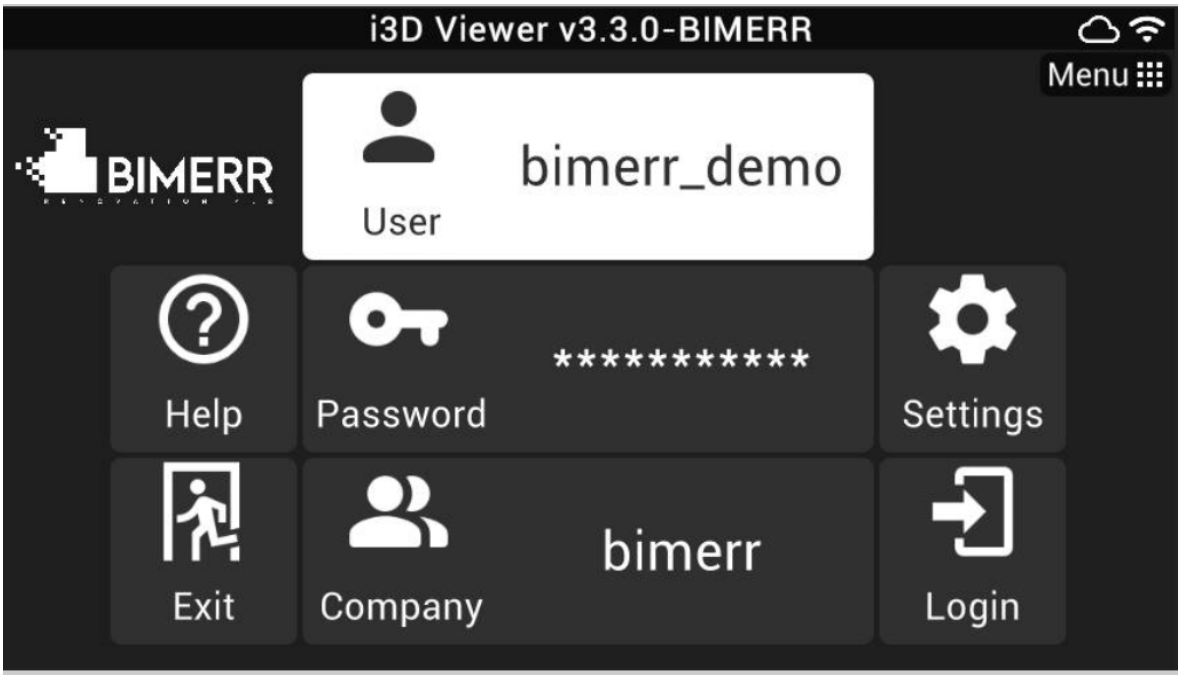

Figure 11 Log-in screen

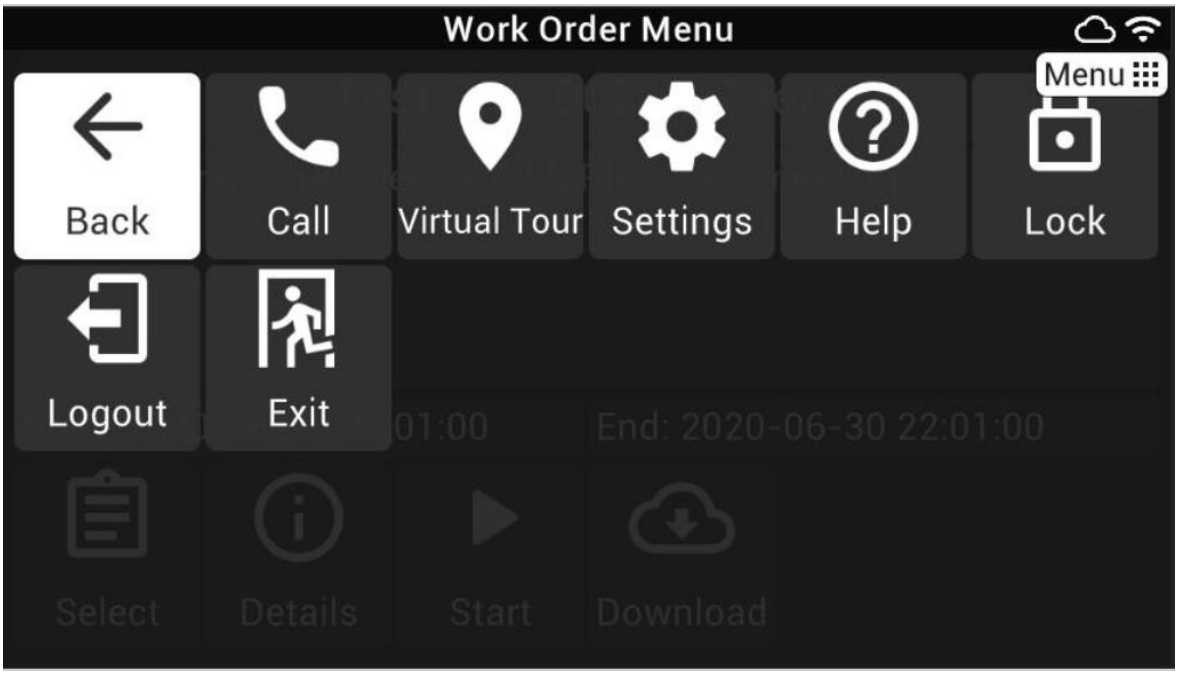

Figure 12 Lock / Log-out / Exit

3.2.2 User-customization options

The application is prepared to be adjusted to the needs of the user (Figure 13). The user can switch the language of the application. To support operation on different HW, the user can adjust the sensitivity of the gyroscope which makes available to control the application with head gestures. Gyroscope control is an alternative to the voice control on devices, on which the voice control is available in a limited version or is not available at all.

The user is also allowed to set the application to offline mode. In this mode, only the work orders previously downloaded to the glasses are available. The user can execute the pre-downloaded work orders in offline mode. In this case, the report and evidence of work is synchronized with the back-end after the glasses are connected to internet.

Figure 13 Settings

3.2.3 Overview of assigned Work orders – list of tasks

After successful authentication, the list of tasks assigned to the logged in user is displayed. The whole list of assigned tasks is displayed, ordered by the expected date and time of execution (Figure 14). Via this list, the worker gets always overview about the tasks to be done. The user can check the details of any of the assigned tasks (Figure 15), download them to the glasses for offline use or start the execution of any of the tasks (Figure 16).

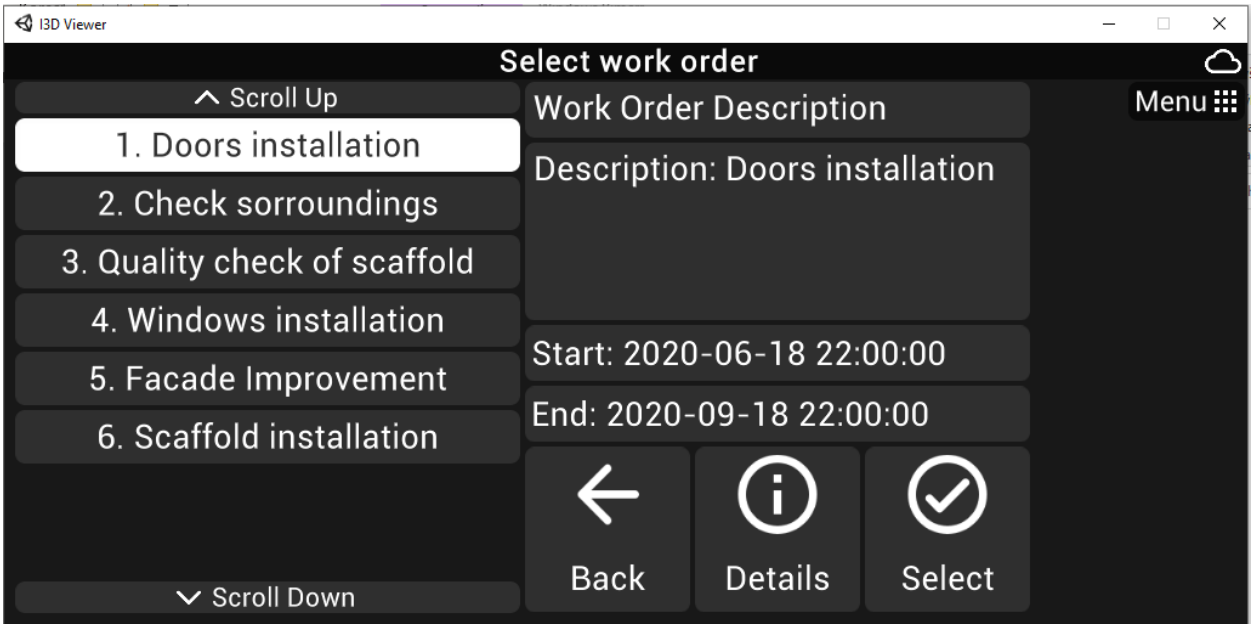

Figure 14 List of assigned tasks (work orders)

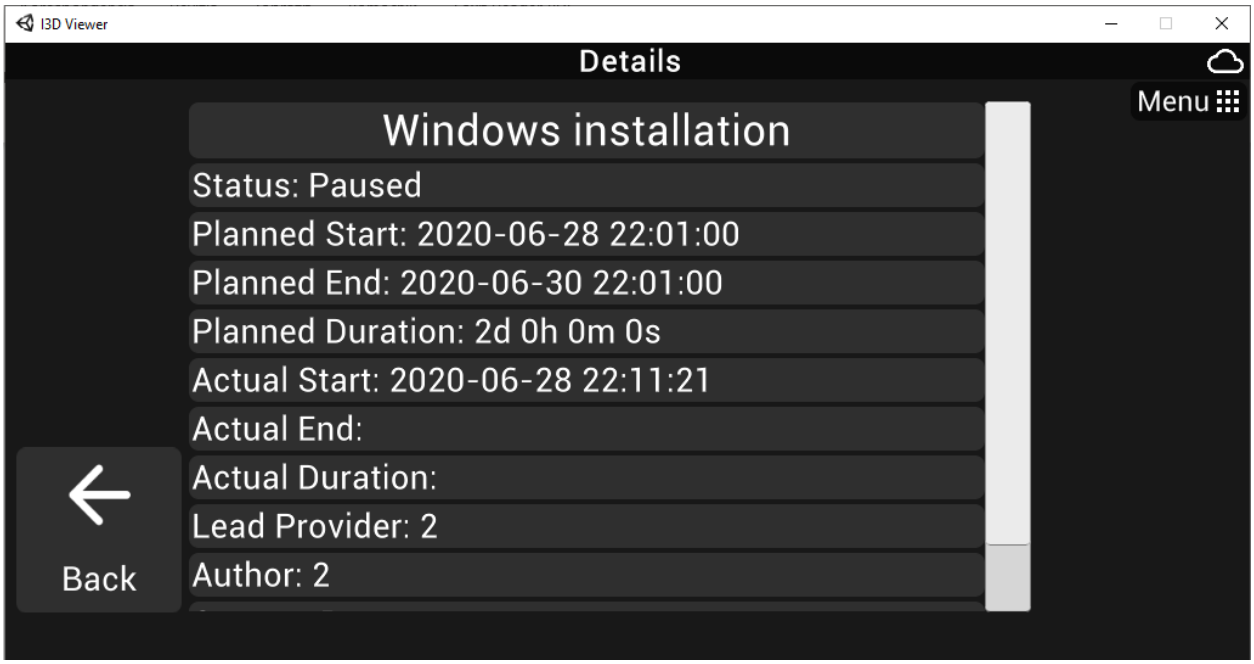

Figure 15 Details of an assigned task (work order)

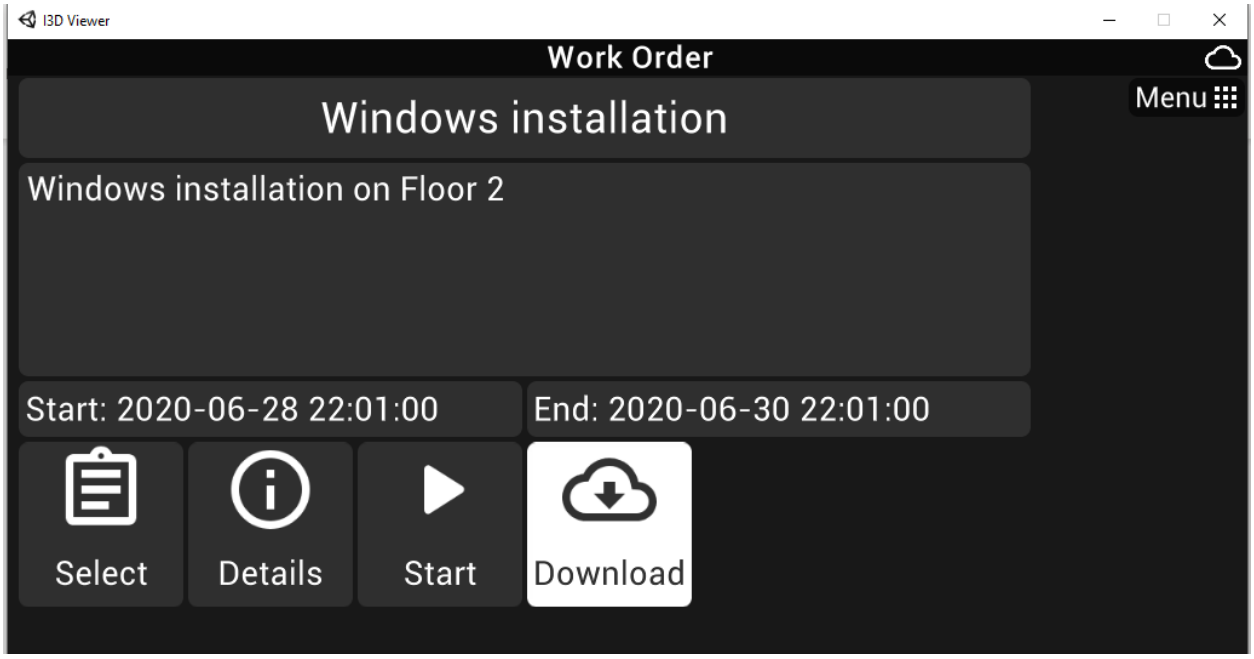

Figure 16 Manipulation with the task - view the details; start the execution; download to be executed in offline mode

3.2.4 Work order execution and Task level reporting and evidence

After the worker starts the execution of a workorder, the system guides him step-by-step trough the tasks of the work order. The worker is asked to start the execution of the oncoming action (Figure 17), while detailed description of the work to be provided is available. Once the worker starts the execution of any of the tasks, the application allows to attach as many multimedia files (pictures, video, and audio recordings) to the report as evidence, as needed (Figure 18). These multimedia files are linked to the tasks of the work order. After the worker finishes the execution of a task, the application requires from the worker to set the status of the task (Figure 19). To every task, also a textual note can be attached. In case, it is expected to collect some value, an input field to enter the collected value is available to the worker.

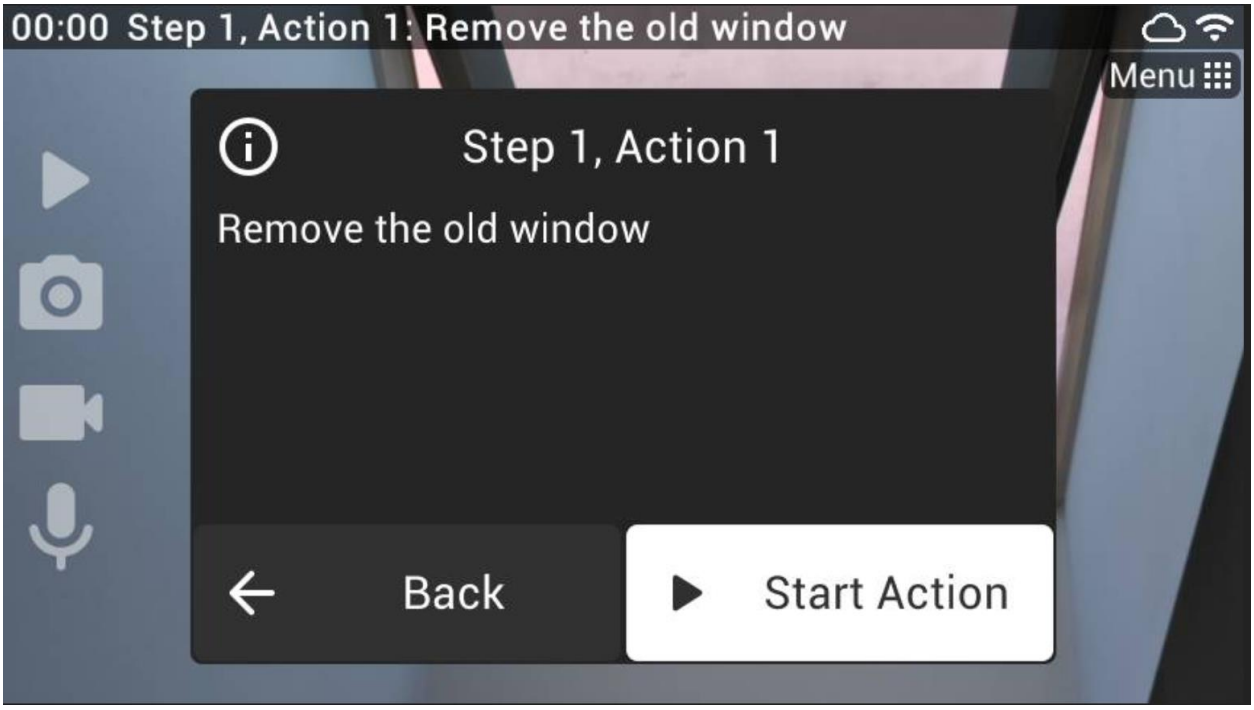

Figure 17 The start of execution of every task is confirmed by the worker

Figure 18 Quick buttons to attach evidence in form of multimedia files are available during the task execution

Figure 19 After the execution of a task is finished, the status is set by the worker. Where it is needed, notes and measured values can be attached as well.

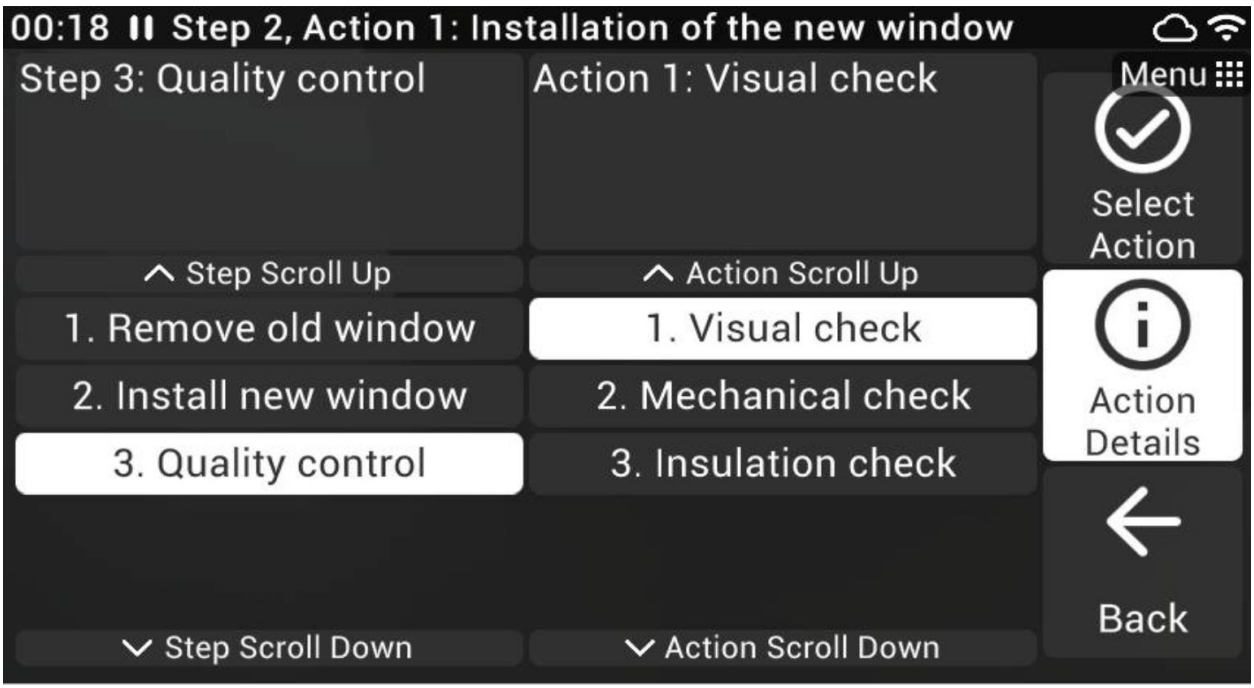

Figure 20 List of tasks of the work order

The user can anytime check the list of tasks of the actual work order, in which the status of tasks execution is indicated (Figure 20).

After the whole work order is finished, or if for some reason the worker needs to quit the execution, the application requires to set the status of the work (Figure 21). Available options are: Completed, Aborted and Paused.

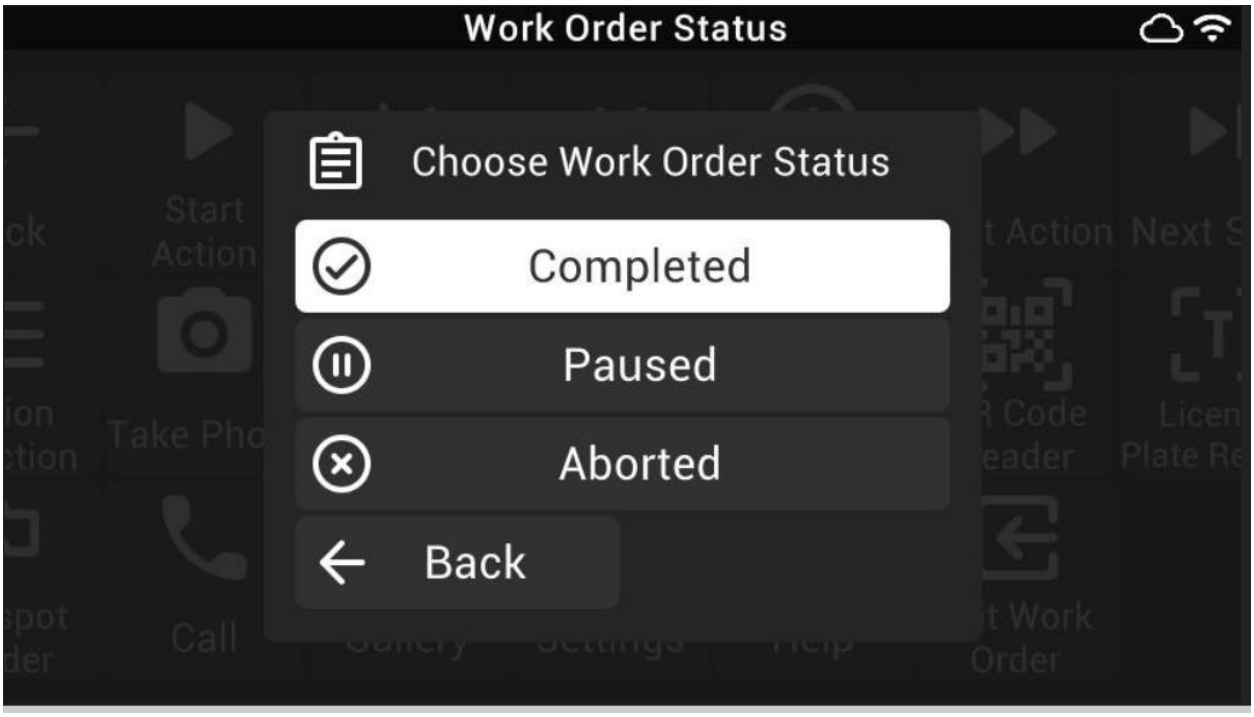

Figure 21 Statuses of a work order

The execution of the tasks is supported with additional tools (Figure 22), like QR code reading, barcode reading or license plate reading. The user is also allowed to call other users to ask for instant remote assistance. The rest of the buttons are for easier navigation in the list of assigned tasks.

The user can also customize the quality of the video recordings, based on the actual preferences (Figure 23). In case, a short video to document the status is required, High quality of the video recording is recommended. From the other hand, if, a long process is recorded for evidence, it is recommended to record in medium or low quality to keep a reasonable size of the recording. The resolution of the three predefined qualities are 854 x 480px for High Quality, 512 x 288px for Medium Quality and 256 x 144px for Low Quality.

The recording of video can be also automatized. If this option is selected (by button “Record each action”), a video recording about each action is created automatically. The user can anytime change this setting based on his own preferences.

Figure 22 Tool set available for the worker in the app for mobile devices

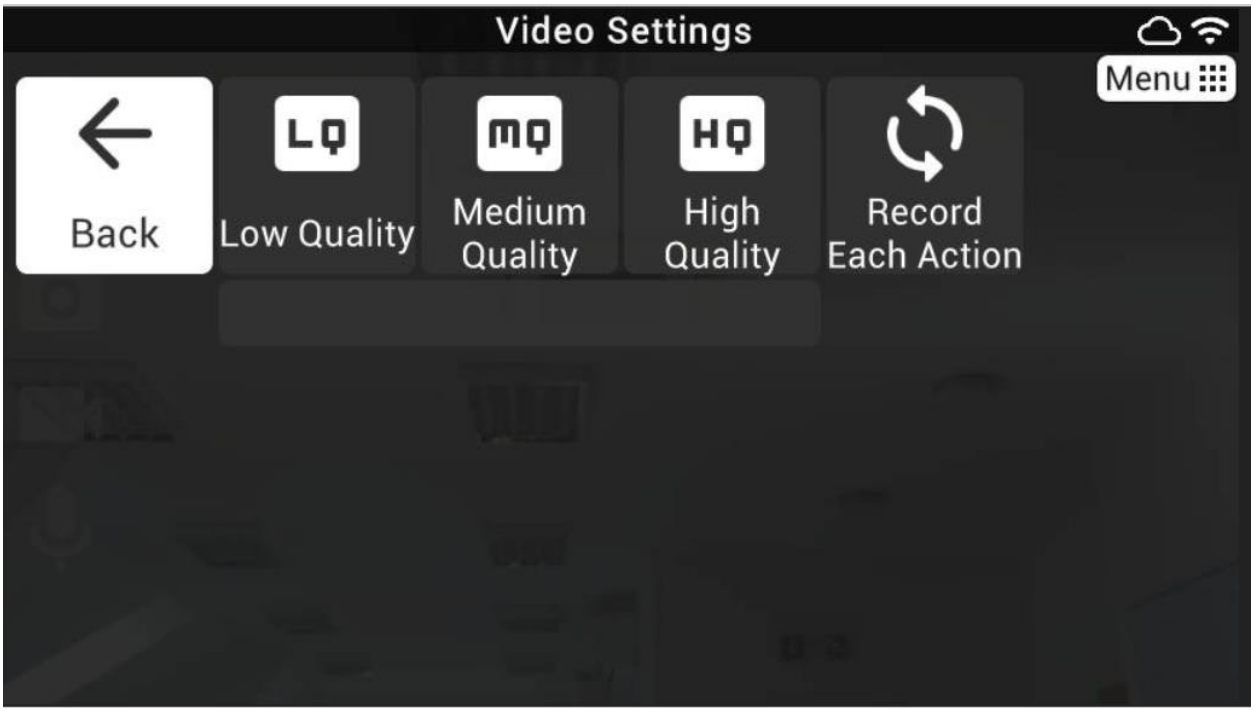

Figure 23 Adjustable video recording quality

3.3 BACK-END

The application aims to provide in-the-field guidance on several fronts: e.g. to alert workers to hazardous components, assist them in reporting work progress (which will be automatically synchronized across BIMERR tools to provide all stakeholders an up-to-date view on activities and actual progress), guide them in the process of installation/assembly based on vendor information, etc. To achieve this, a back-end and deep integration with other BIMERR components is required. Since the app is an additional UI for the Workflow execution engine (D6.6), the components of the engine are used to produce content to be displayed in the smart glasses.

3.3.1 Workflow management

The workflow management part of the tool described in D6.6 is intended to be used to create and manage the know-how of a plant or company. In context of BIMERR, it is a repository of work processes, which are connected to a building reconstruction process.

A work process template can be a process definition from different perspective. It can be

a) the whole reconstruction process containing an overview and scheduling of the main tasks, such as scaffold installation; safety measures installation; facade renovation; windows replacement; quality control
b) or it can be also a detail definition of some of the tasks, e.g. the process of installation of the new window or process of the quality check after the new windows has been installed. In the perspective of this deliverable, the second approach is important.

The workflow definition and management tool allow to create a step-by-step process definition, which needs to be followed by the worker on-site to achieve the wanted results by execution of the assigned tasks. This set of instruction can be e.g. a definition of a process of installation/assembly based on vendor information.

3.3.1.1 IMPORTING A WORK PROCESS SAVED IN A BPMN FILE

The manual work of the technologist using the workflow creation tool can be reduced in case, the work processes are already defined in third-party tools. The workflow engine provides the connectors to import any kind of work process defined in BPMN format (Figure 24).

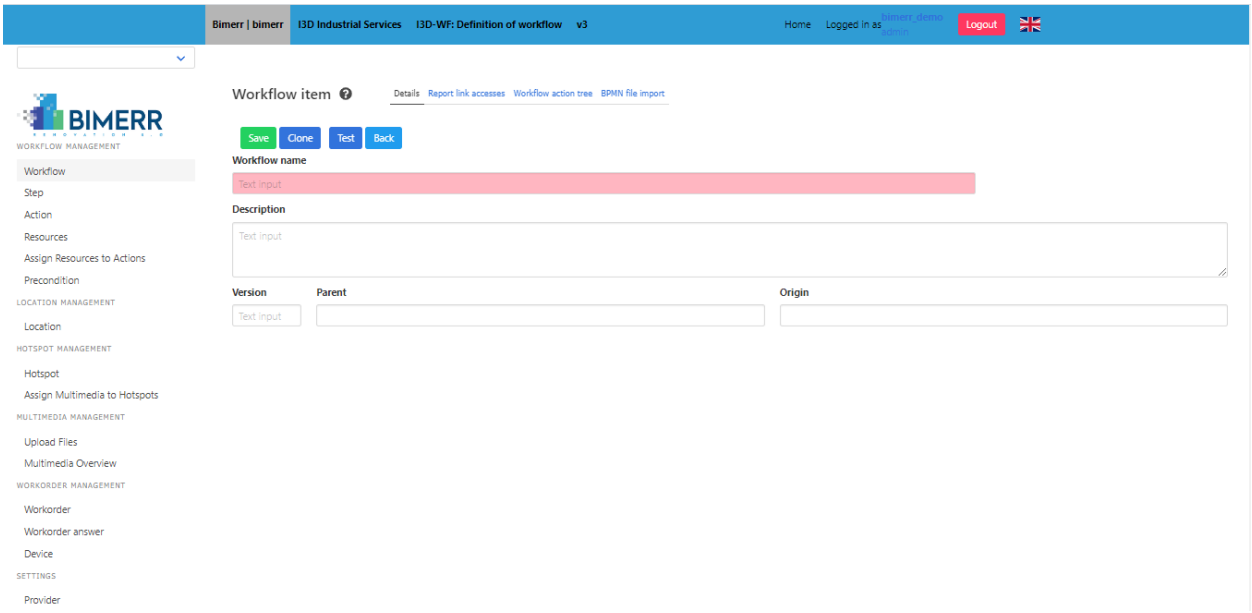

Figure 24 Creation of new workflow with option to load a BPMN file

The same work process can be imported from BPMN file multiple times, every time a new version of the work process template is created in the I3D system. For future reference, the external ID of the process is kept and displayed in the UI to inform the user about the fact, that it is an imported workflow created and initially managed outside the I3D (Figure 25).

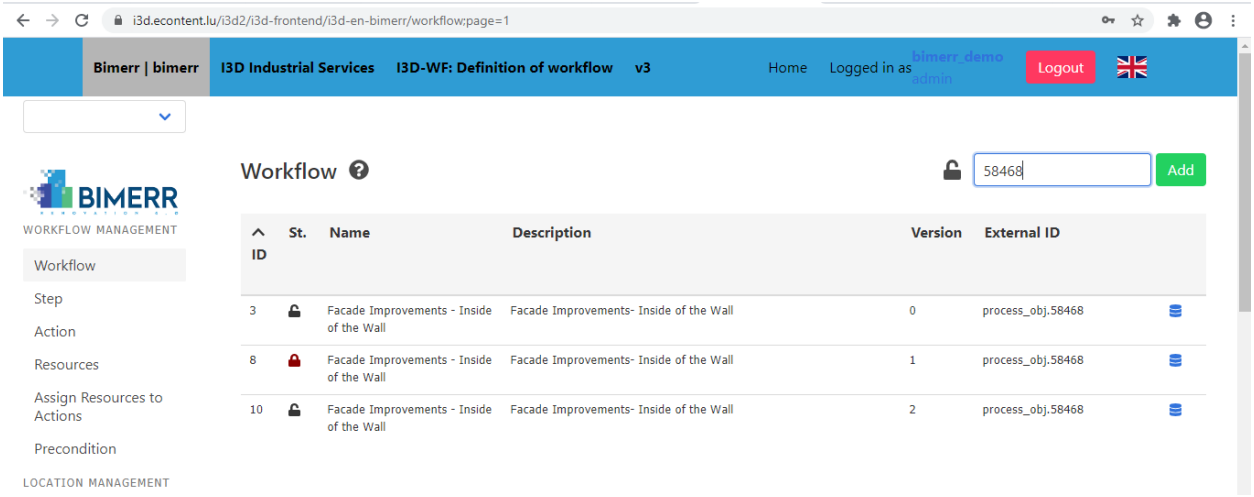

Figure 25 List of work process templates based on the BPMN with same external ID

The BPMN file contains all the information about the work process. It contains the sequence of tasks, their attributes, assigned KPIs and sometimes also the scheduling. The ETL tool of I3D is trying to collect as much information as possible. On top of it, the project manager has always the opportunity to extend the workflow with additional information as well as to modify the imported ones.

3.3.2 Digital twin (work order) creation

A work order or a so-called Digital Twin of a work process in context of I3D is an executable set of tasks. Any approved workflow (work process template) can be used to create as many real instances, as needed.

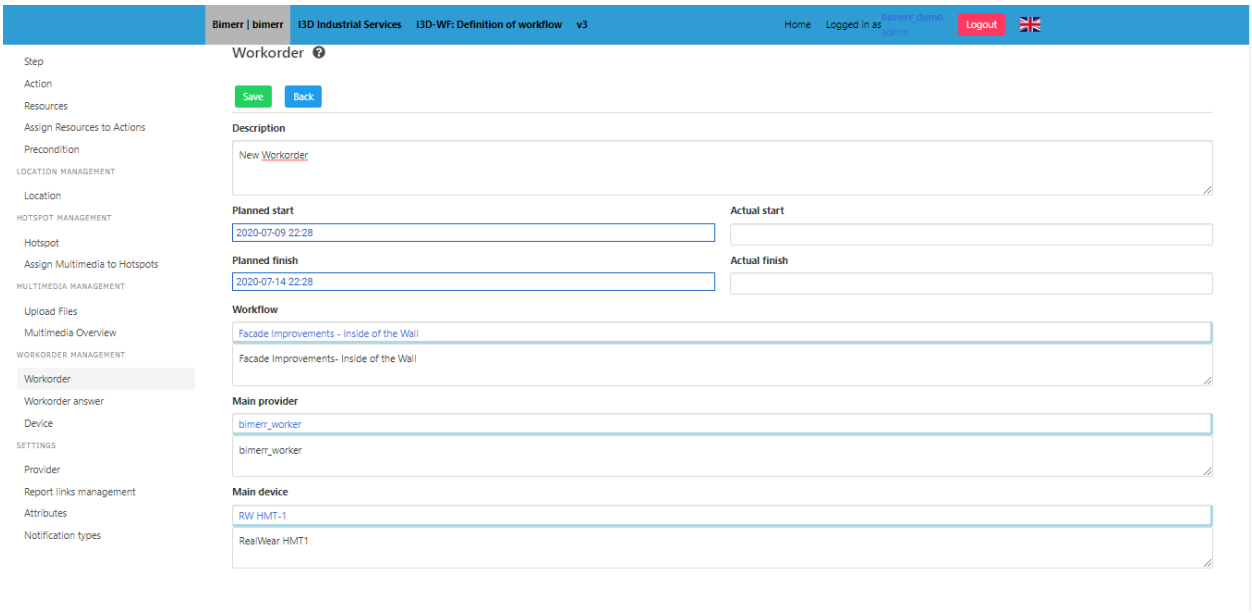

Figure 26 Creation of a workorder - digital twin

In the moment of creation of a digital twin (Figure 26), the exact work process template is processed, and an empty process log is created, which contains only the planned values of attributes (Figure 27). Before the process of creations is started, the planned starting date and planned finish date, as well as the responsible main provider needs to be set.

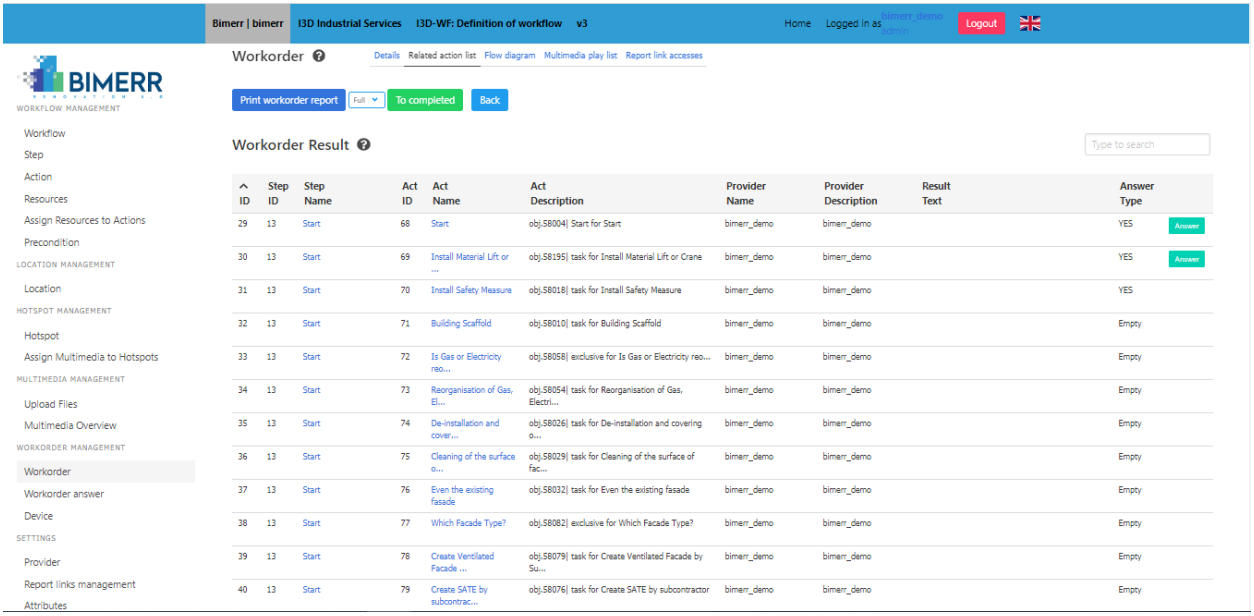

Figure 27 Empty process log created

Every work order is assigned to a user, a main provider, which is responsible for the execution. Only the main provider and the operator who created the work order has permissions to access and manage the work order.

3.3.3 Digital twin monitoring and management

The I3D provides different User Interfaces (UI) via which the work order can be managed. The most important are

a) the web-based interface, which is supposed to be used by the project manager and
b) the other UI is the application described in this deliverable, which can be used on mobile and wearable devices, such as smart glasses, cell phones and tablets.

While the web-based UI focuses more on administrative users, like project managers, the application is intended to use by workers, foreman, quality controllers and other on-site users.

The project manager can follow the status of execution of any of the reconstruction tasks via graphical visualization of the work order. This provides a quick overview for the project manager about the overall status of the reconstruction process. The statuses of the tasks are visualized by green, red, and grey colors to indicate, which tasks has been executed correctly and which not. Interaction with the tasks can be done by clicking on the elements in the flow diagram (Figure 28).

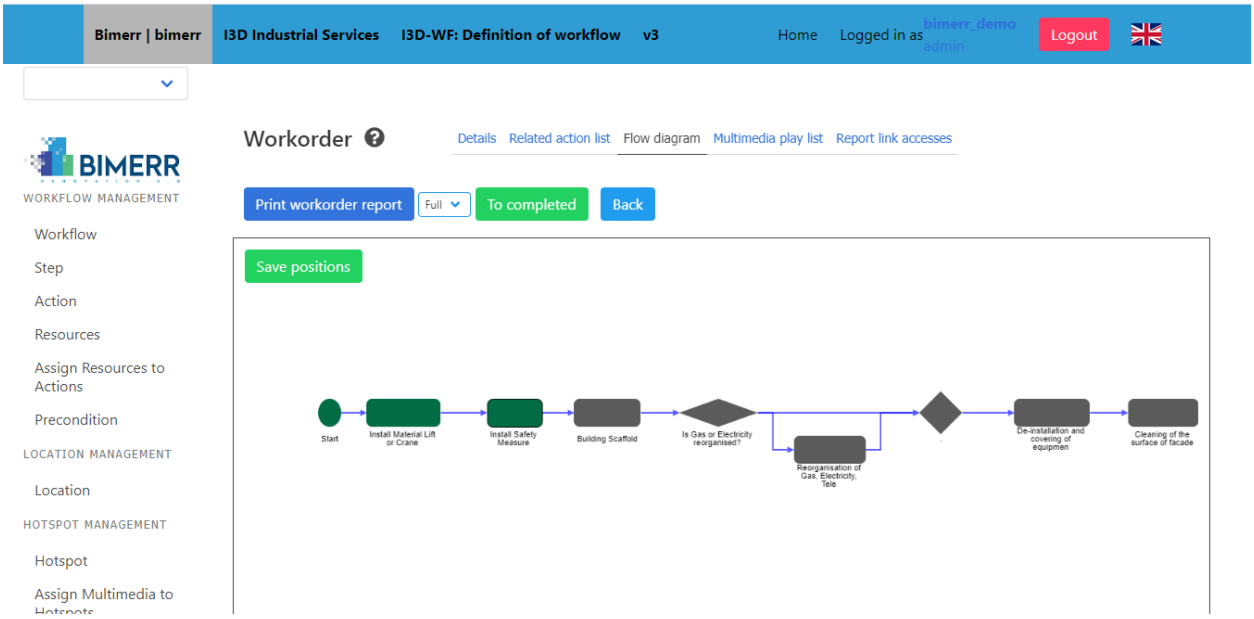

Figure 28 Visualization of the running work order

3.3.4 Digital twin Process log

As it was already mentioned, the key requirement for the workflow execution component is to orchestrate the reconstruction process and to transparently inform all the stakeholders about the status of the reconstruction as well as about the planned tasks and related H&S issues. On top of it, every real execution of a process based on the same work process template, provides a feedback in form of real recorded data. A database of historical data collected during execution of different instances created from the same work process template provides opportunities to fine-tune the work process in order to get it better adopted for unforeseen circumstances which can negatively affect the upcoming execution of the reconstruction process.

In the first version of the Workflow execution engine, two types of data exports were made available via REST API calls. Knowing the external ID of the process imported to the system from a BPMN model, a list of digital twins generated from the process template is reported (Figure 29). The second REST API endpoint provides detail data about a digital twin with all the data related to the selected work order (Figure 30). This process log is in form of structured JSON, which makes it easy for other component to process and extract the data needed.

Figure 29 REST API Output - JSON with a list of work orders created from a selected work process template

Figure 30 REST API Output - JSON with process log of the selected work order

4. INTEGRATION WITH BIMERR TOOLS

This chapter contains a detailed view on the integration strategies used by the different components to interact with the BIF and between them. Integration of the application is realized primarily to this component. Integration with the rest of the BIMERR tools is realized via the Workflow execution engine.

4.1 INTEGRATION WITH WORKFLOW EXECUTION ENGINE (D6.6)

The application for on-site support of workers and the Workflow execution engines are created in parallel, thus their integration is implicit by their architecture. The application for workers uses the workflow execution engine as its back-end and the applications are sharing the same database structure and REST API, which is used by the Web-based GUI used by the Project manager.

The workflow execution engine allows to define and manage work process templates and by using these templates to generate real executable work orders. These work orders can be executed directly in the web interface of the workflow execution engine by the project manager or by workers using the application for on-site support.

The same approach will be followed with integration to the notification system, which is going to be implemented as part of the D6.7 “Adaptive workflow management & automation tool 2”.

4.2 INTEGRATION WITH MODELING TOOLS

Since the Workflow execution engine is only one of the components of the PWMA toolkit, it is important, that it works in an integrated way. As it was already mentioned, the BPMN standard format has been selected as a common communication language between the modeling components and the execution engine. Selection of this standard is a far-seeing decision which allows to replace the modeling tool, or the execution tool as well. In this version of the tool, the BPMN model is exchanged between the modeling and execution tool manually. The final solution will contain deeper integration via APIs, which will allow to do the exchange in automatized way.

4.3 INTEGRATION WITH BIF AND BIM MANAGEMENT PLATFORM

As described in detail in the BIMERR Deliverables D4.4, D4.6 and D4.8 (BIMERR Consortium, 2020 D4.4, D4.6 D4.8), the BIMERR Interoperability Framework (BIF) essentially allows any application and tool developed in BIMERR to exchange building-related data, ranging from building data and occupancy data to renovation process data, in a meaningful an secure manner. In this context, the BIMERR Renovation Process Simulation Tool practically acts both as a building-related data provider and consumer in order to effectively enable the anticipated data exchanges with other BIMERR applications.

From BIF point of view, the workflow management and automation tool will act both as data provider as well as data consumer. In the role of data provider, it will provide for other components all the data collected and created about the ongoing reconstruction process in form of process log, which will contain specific data about the tasks of the reconstruction process (e.g. to update BIM with workflow related data). In the role of data consumer, several data will be collected from BIF such as (a) the hierarchy of the locations extracted from the BIM Management Platform, (b) weather forecast, (c) resources available, and (d) other data from legacy system, which will be identified in later stages.

Implementation of the integration to the BIF is planned in the second iteration of the toolset. Based on planned discussions with the representants of the end users, it will be defined which data is available in other systems and which need to be automatically collected by the workflow management & automation tool.

4.4 Integration with App for residents

Integration with the App for residents is realized via the process log of the digital twin, via which up-to-date information about the running process are shared. Based on the provided information, the app for residents can indicate for its users important details and information about the on-going reconstruction process, like the progress of the reconstruction work, to indicate the issues, delays, schedule of on-going tasks and other circumstances of the reconstruction process. Instant information exchange is going to be realized via the notification system.

4.5 Integration with Monitoring tool

Accessing data from the Workflow execution software by other components of the PWMA toolset is as important as importing the BPMN model. The deployed REST API of the Workflow execution engine provides all the information needed for further analysis and evaluation of the work process models.

The data provided by the web-services are used by the KPI dashboard of the modelling environment to show the real KPIs. In the actual version of the prototype, only the current execution time KPI is implemented, but the final solution will deal with all the followed KPIs.

5. CATALOGUE OF TOOLS

This chapter describe where and how to access the tools presented in this deliverable.

5.1 WORKFLOW EXECUTION ENGINE (D6.6)

The workflow execution tool is available in form of SaaS on address https://i3d.econtent.lu/bimerr/.

A new user needs to register via “Ask for registration” (Figure 31). In project name, do not forget to enter “bimerr”. After successful registration, the administrator of the "bimerr” installation will activate the registered user and assign a set of user roles for the user.

Once the registered user is activated, it is possible to log in to the system and use the features described in this deliverable. The installation “bimerr” contains the demos described in this deliverable and is open to create and deploy own work processes, which becomes available to execute via the mobile application (5.2).

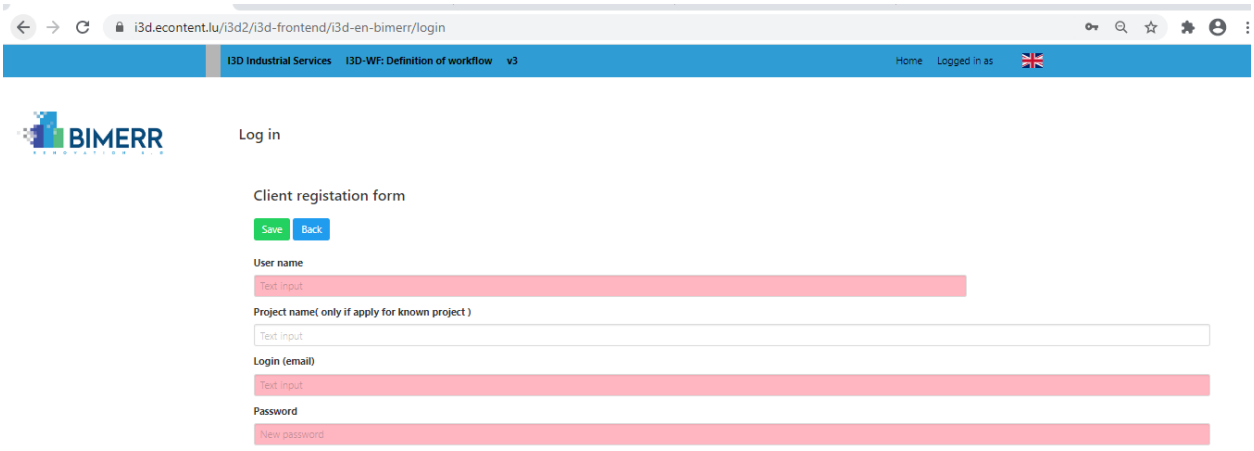

Figure 31 Registration form to become a user of I3D

5.2 SMART GLASS APPLICATION FOR ON-SITE RENOVATION WORKER SUPPORT

The application for mobile devices and a demo version runnable on Windows can be downloaded from https://i3d.econtent.lu/bimerr/download/.

The user credentials for the application are the same, as for the web interface, or alternatively, the user of the web interface can create a new user. The “company name” need to be set to “bimerr” (see Figure 32).

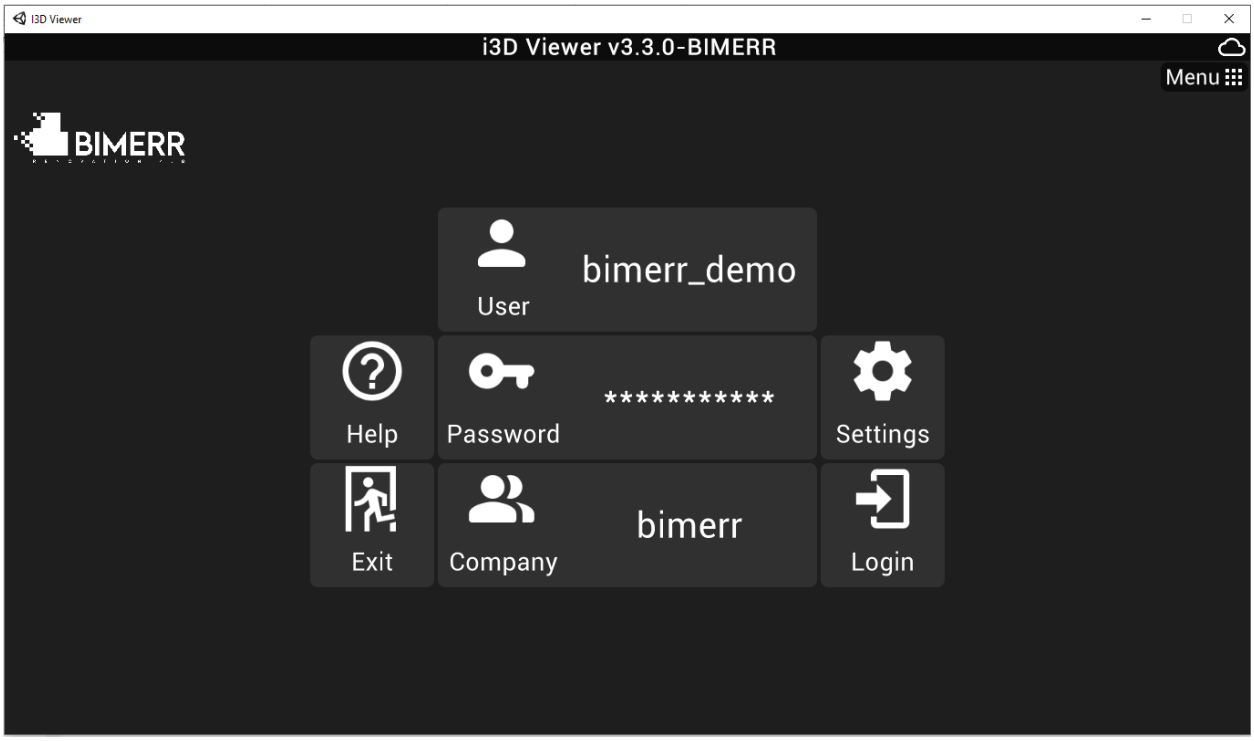

Figure 32 App log-in

6. Conclusions and Outlook

The technology that is described in this deliverable corresponds to the approach that is described in D6.2 “Adaptive Renovation Process & Workflow Models 1”. This approach is going to be updated in a second iteration which will lead to updates in the workflow execution engine as well. The second version will be aligned with the final list of user requirements.

This deliverable introduces the first version of the application for on-site support of the workers and the related back-end – the workflow execution engine.

This document explains the smart-glasses application:

- First, description of the I3D system and terms used
- Second, description of the main functionalities of the application, which are user authentication, work order overview, interaction with assigned task and reporting on the executed tasks.
- Support for selected wearable smart glass.
- Integration to the other BIMERR tools

The update of this tool set in form of next iterations will focus on

- Support for new smart glasses, including the HoloLens selected as reference smart glass for BIMERR
- in the next version, the mentioned push notification system will be integrated, too. This will provide the opportunity for direct communication between the components of the PWMA components. E.g. the worker will be able to directly notify the residents in form of push notification about unforeseen issues or not planned activities.

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