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DELIVERABLE D6.7
Adaptive workflow management & automation tool 2

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ACRONYMS

Acronym	Meaning
API	Application Programming Interface
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
I3D	Industrial 3D services
KPI	Key Performance Indicator
PWMA	Process & Workflow Modelling & Automation
SaaS	Software as a Service
UI	User Interface

EXECUTIVE SUMMARY

This document describes the final version of the Adaptive workflow management & automation tool, which is the main tool for project manager and involved stakeholders to manage and monitor the status of the whole reconstruction project.

The provided tool is a standalone toolset based on the I3D platform adjusted to the needs of the BIMERR, which provides the set of tools covering the whole life cycle of the project management.

Main available functions are:

- Importing the workflow created in the PWMA Workflow and simulation modelling tool
- Management of the workflows
- Creation of workorders as workflow digital twins – real running instances of the processes
- Monitoring and management of the workorders and tasks
- Exporting data and process log to other components
- Communication between Site manager, Foreman and Workers

While the first version focuses on covering the main integration to other BIMERR components in terms of importing the process templates and reporting the process log, the second version of the tool is focused on deeper integration with other components of the BIMERR ecosystem to utilize the BIF and extend the BIM with valuable data.

The functional capabilities are based on the user requirements identified in D3.1 and defined in the corresponding D6.3 “Adaptive Renovation Process & Workflow Models 2” and D6.5 “Renovation Process Simulation Tool 2”. The deliverable at hand therefore explains the technical concepts, the tool functionality of the requested features and provides the web-based application, which is made available as SaaS at https://i3d.econtent.lu/bimerr/ .

In parallel to the iteration of the D6.3, which improves the way how renovation process management is performed in the BIMERR, this document correspondingly adapts the tool set to provide better support for the renovation process execution and orchestration as well as to better integrate 3rd party tools into the updated renovation process management ecosystem.

1. INTRODUCTION

This chapter describes the main objectives and goals of this particular deliverable, as well as a methodology behind its development and integration. It also describes about the changes that were made since the previous deliverable.

1.1 SCOPE AND OBJECTIVES OF THE DELIVERABLE

This deliverable provides set of features for Adaptive workflow management & automation

This deliverable corresponds to Deliverables D6.3 "Adaptive Renovation Process & Workflow Models 2" and D6.5 "Renovation Process Simulation Tool 2" and provides the technological basis to perform renovation process execution. This document therefore focuses on the tools that are provided for enabling the renovation process management.

On the market, there exist several project management tools, which provides tools for a project manager to manage any kind of project. But most of these tools focuses only on selected stakeholders and are oriented rather on management than on provision of transparent access to data for different user groups in different level of granularity. To ensure hassle-free integration with other components, especially with the (a) applications for on-site support of workers (D6.9) and for (b) renovation progress monitoring and alerting application for residents as well as (c) the BIMERR Interoperability Framework (BIF), we decided to stick to the workflow management and execution platform called I3D.

Since the platform was initially created as a standalone toolset to define and manage workflow templates, and to manage assignment of tasks for workers with smart devices, it contains all the basic functionalities needed to manage a reconstruction process. These functionalities were adjusted and extended to cover the user requirements for a valuable BIMERR component.

This deliverable introduces the workflow definition and management platform I3D, which is available for the project as SaaS. The deliverable is closely connected to D6.9 *PWMA Application for On-Site Renovation Worker Support* which uses the platform as back-end.

1.2 CHANGES FROM DELIVERABLE D6.6

The deliverable addresses the aforementioned objectives in following forms:

1. There is an option to show flow diagram to all workflows.

2. We added new types of actions based on the BPMN methodology, such as exclusive gateways, parallel gateways, service tasks, and ramifications of actions.
3. There are definitions of service tasks, timeout tasks, and lanes for different users.
4. There is a Workorder owner as a main manager for each workorder as well as assignment users, if more BPMN lane roles are defined.
5. We included a description on how a user needs to fill the variables for service tasks imported from BPMN definition.
6. There is now an option to define Health & Safety issues, attach them to specific spaces and set them timed notifications.
7. We included a description on how to use the notifications from worker's view.
8. We described the use of notifications for managers and web application to manage notifications.

2. DESCRIPTION OF THE I3D WORKFLOW EXECUTION ENGINE

This chapter contains a detailed view on the main features of the Workflow execution engine which provides the tools (a) to define and manage templates of work processes, (b) to generate executable digital twin of the process, (c) to monitor the digital twin and (d) to share the details and status of the digital twin with third party systems in form of process log and in form of push notifications.

2.1 THE I3D METHODOLOGY AND TAXONOMY

Since we already possessed a solution similar to the propositions, the main process of works consisted of building on the foundations of our systems according to the BIMERR prerequisites. Our I3D system was constructed with a thought of a comprehensive and multifunctional tool allowing to manage multiple various workflows and users and creating a robust solution suitable for most working environments.

During the development of the BIMERR addons, we discovered several troubles and restrictions, which needed to be addressed. We tried several approaches during the development, not sticking to any particular type indefinitely. We used a lot of prototyping and testing, sometimes directly in the working environments, with an objective to better understand the needs of the site managers and the workers themselves.

These basic principles of the I3D system were compactible with the PWMA toolset:

- Services to define and manage the templates of work processes. This has been extended with functionality to import work processes in form of a 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 - workorders.
- Execution of the work process – workorders 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.

Since the workflow execution engine is 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.

The data structure of I3D is displayed on Figure 1. 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 allows to skip the execution of any of the actions.

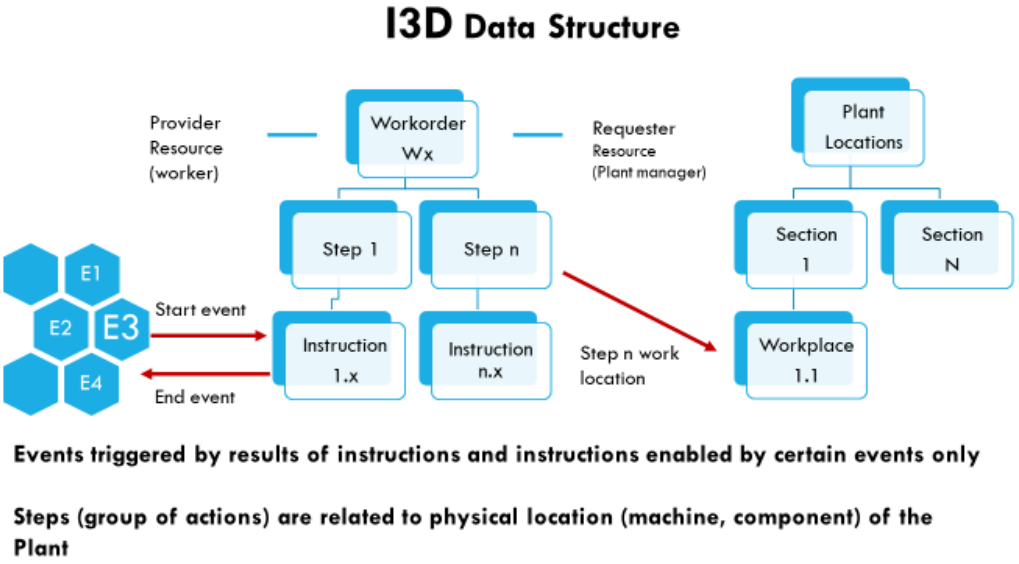

Figure 1 I3D data structure

2.1.1 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 2) of a work process defining where, how, what to do and with which resources.

Alternative to this approach is defining actions succession as BPMN process with connection between actions (see Figure 3).

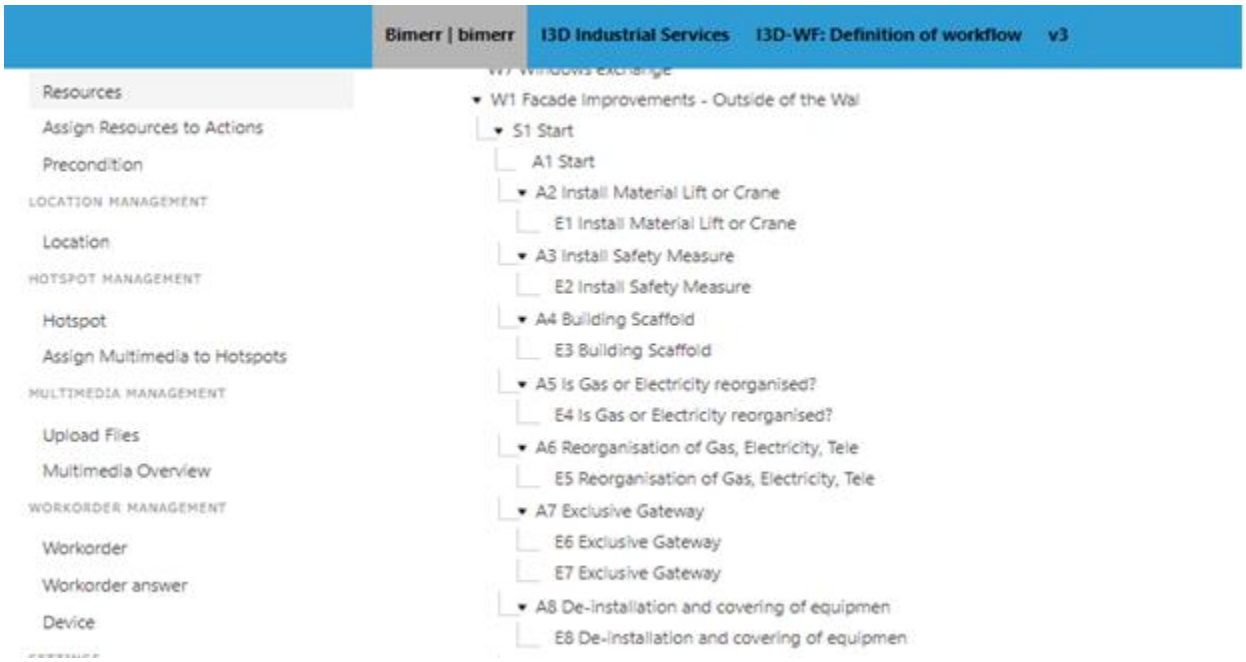

Figure 2 Workflow structure with actions and related events

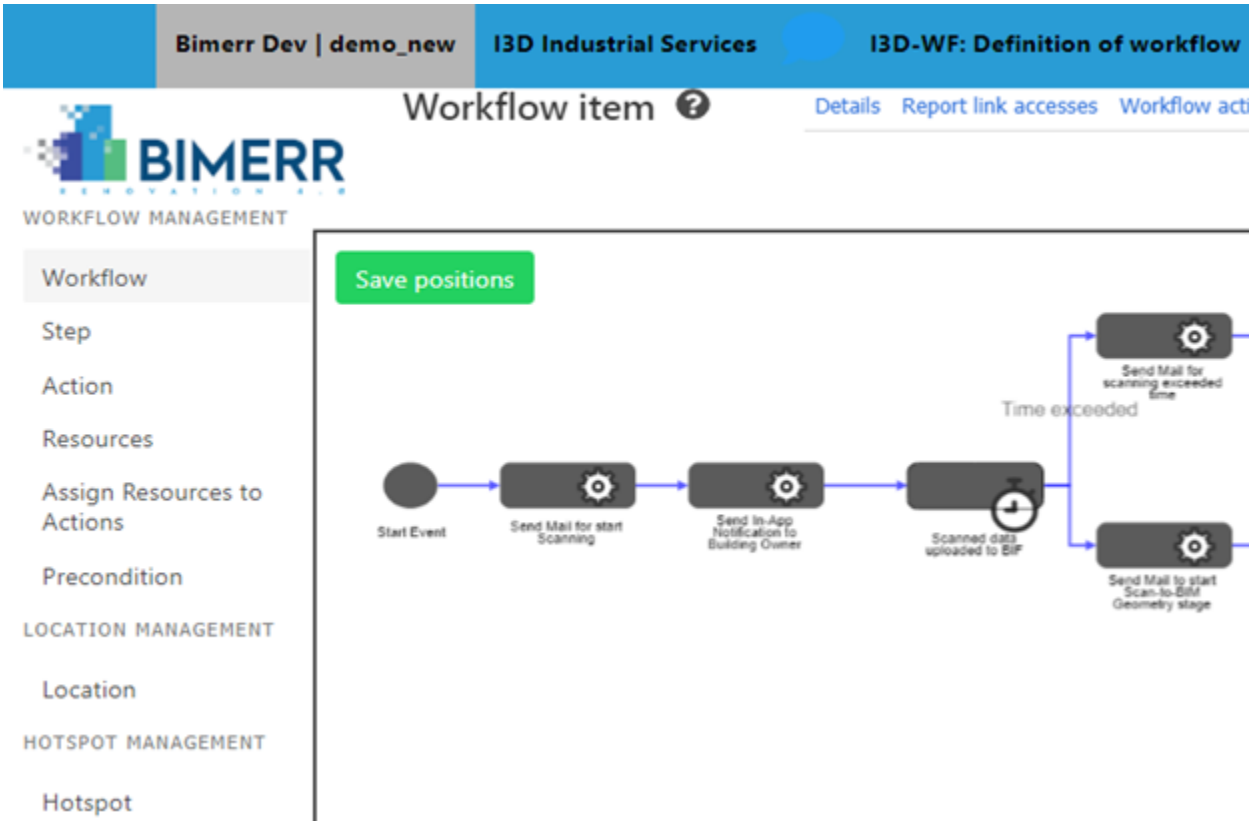

Figure 3 Workflow structure with action tasks and relations between them

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 4) can be used to generate a running instance – a digital twin of the work process called work order.

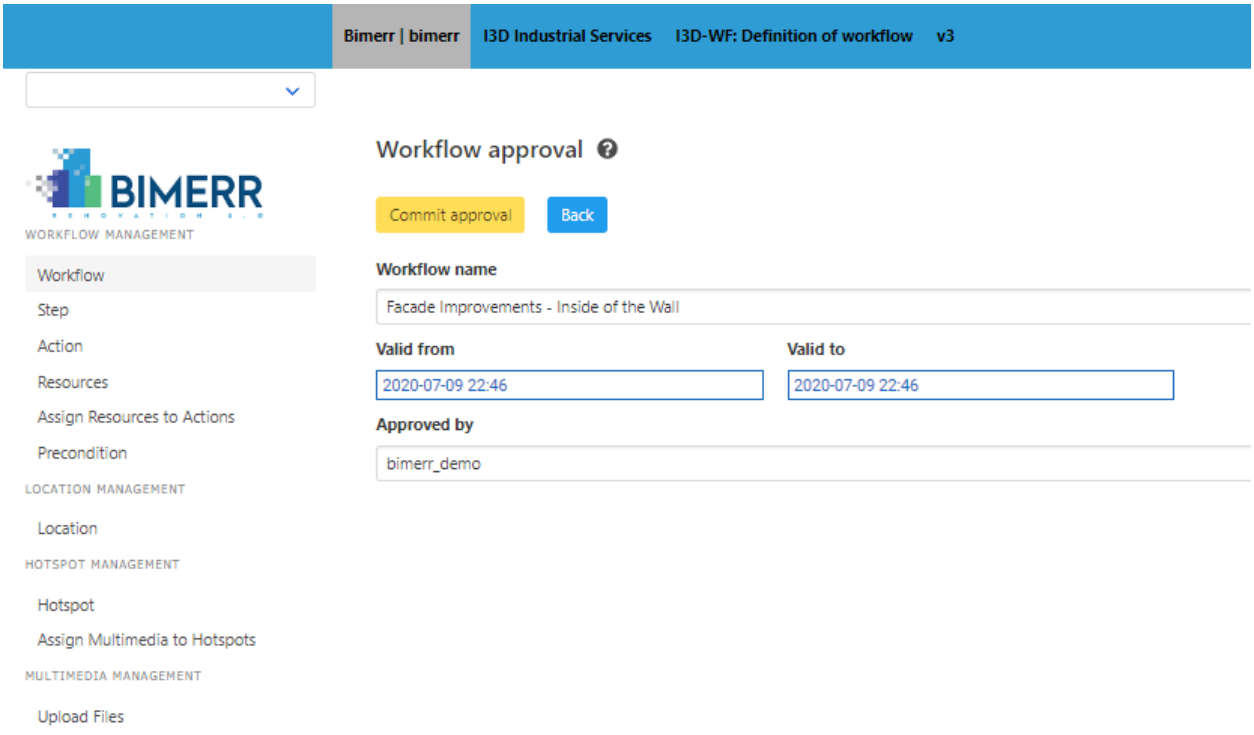

Figure 4 Workflow approval procedure to protect work process template against unauthorized changes

2.1.2 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. Alternatively, each step can have a pointer to one or more following steps, allowing to create more elaborate workflows. 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.

This principle is used when importing a BPMN workflow using only one step. The standard locations (3d panoramas) are not used for imported processes within the BIMERR project – they are instead replaced by special-empty locations.

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

In our implementation for the BIMERR project, we implemented various types of action, which correspond to the BPMN typology. These include *exclusive/parallel gateways*, *start/end events,* and *service tasks*. We added an option to not only follow sequential order of steps and action represented by sequence order numbers, but also to use arrow-like connections between actions, so we can allow ramification and parallel actions.

2.1.4 Event

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.

Figure 5 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.

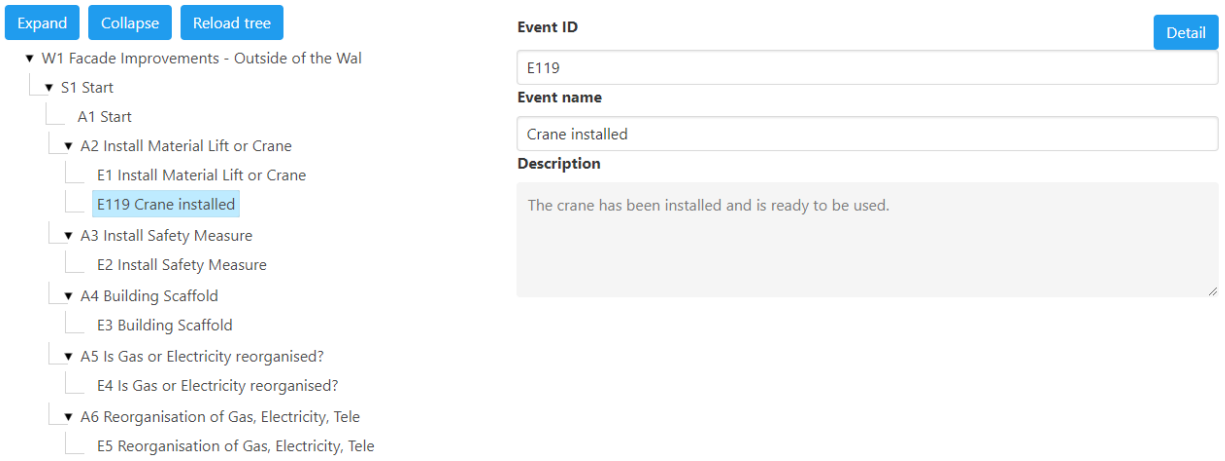

Figure 5 Example of event

2.1.5 Precondition

Preconditions are mathematically defined rules or formulas, which need to be fulfilled before the action, to which the precondition is assigned, becomes executable (Figure 6). 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.

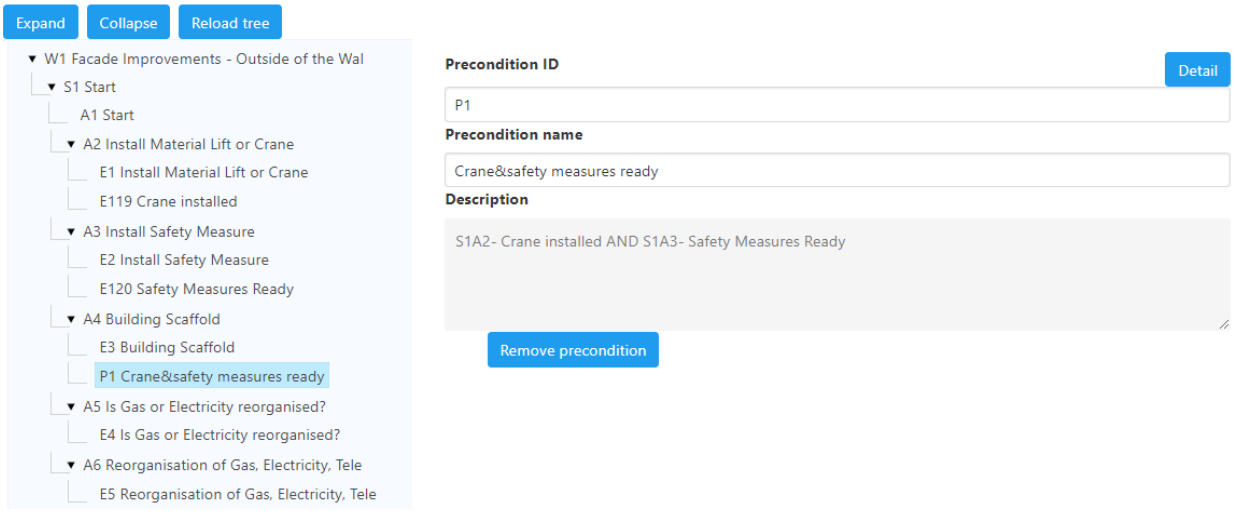

Figure 6 Precondition of an action

Example of definition of preconditions is displayed on Figure 7. 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.

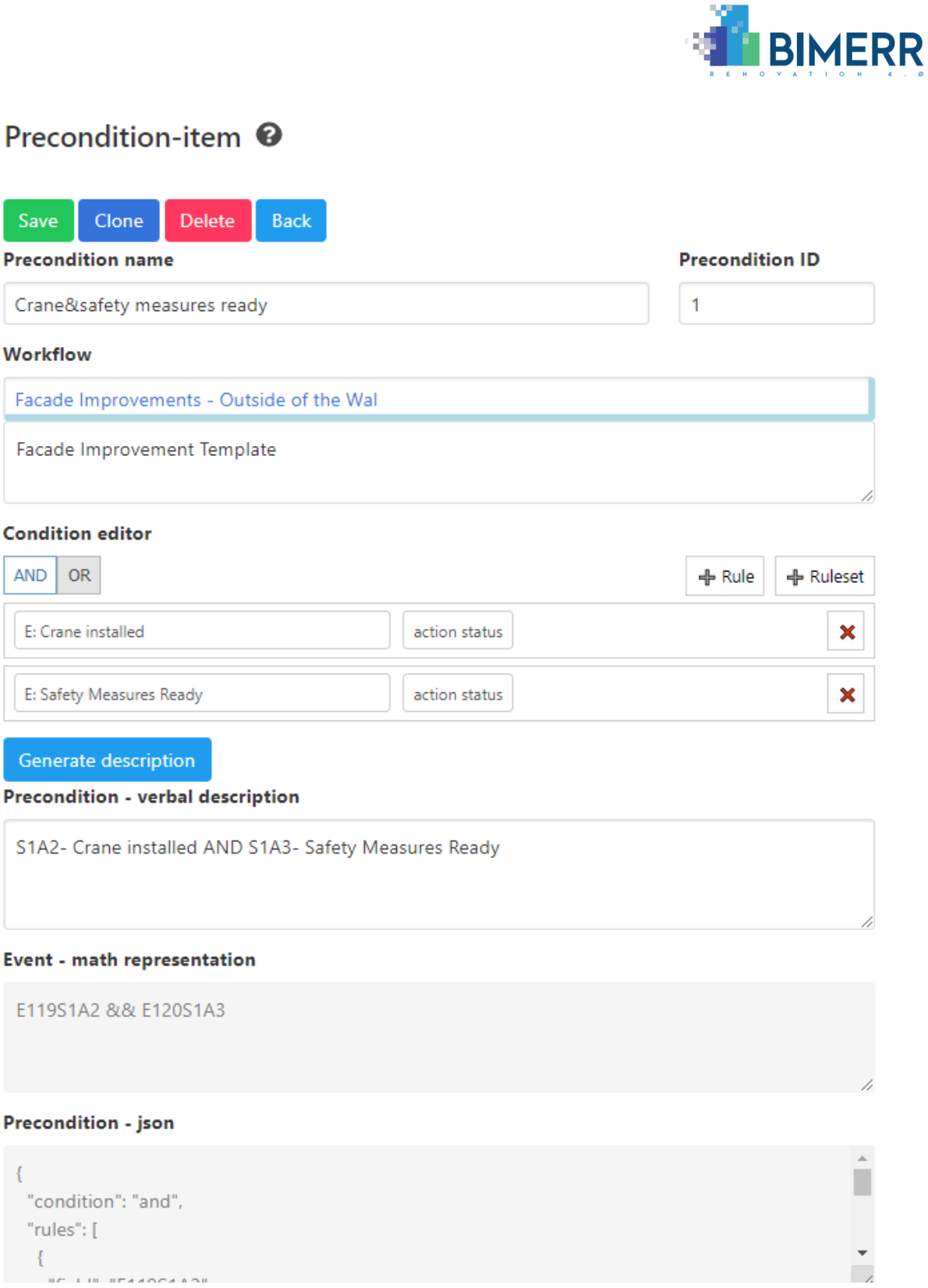

Figure 7 Mathematical, human-readable definition of a precondition

2.1.6 Resource

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. Resources are assigned to actions.

2.1.7 Location

As a separate module of the system providing the toolset to define and manage the location hierarchies, we developed the Location management module. By default, there are three types of locations distinguished in the system – Plant, Section, and Workplace.

Plant is a root node, as it typically defines the plant or the building, to which the workflow is connected. Sections are the inner nodes – typically a building, a floor, or other logical group within the plant. Workplaces are the leaf nodes, where the work itself is going to be typically executed. On Figure 8, 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.

As for the BIMERR project, the workorders use space identifiers extracted from the BIM model.

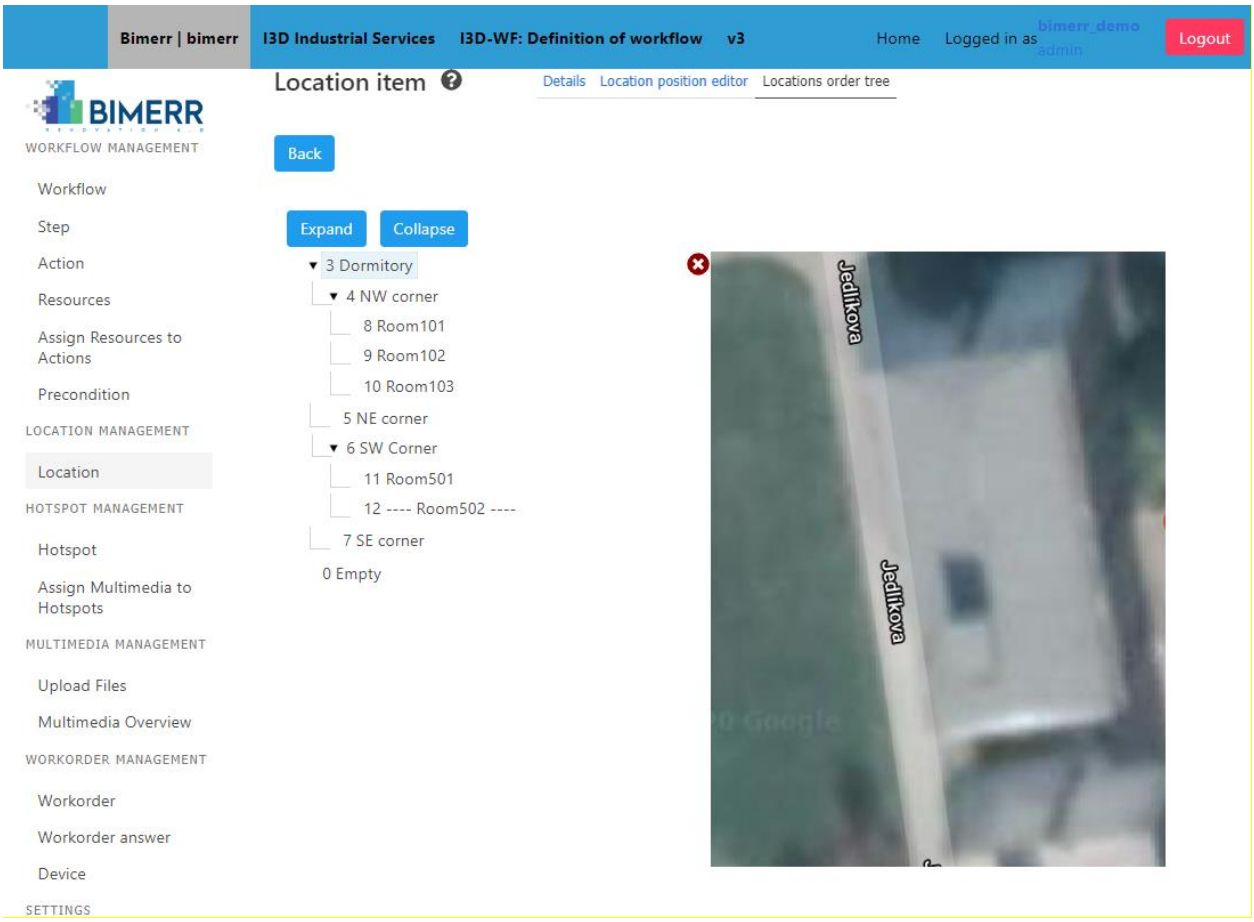

Figure 8 Location tree: root node is represented by a 2D picture - a map cut-out

Every location is defined by its GPS coordinates, a short name, a description, a location type, and a link to the prior location – the location on higher level in the location hierarchy. The locations extracted from the BIM model are transformed to this structure by an internal ETL (Extract-Transform-Load) tool.

2.1.8 Hotspot

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

Every hotspot has its definition, which typically consists of name and description, picture – usually pointer icon or arrow 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.

One hotspot, i.e. thermometer, can be placed on one or more locations and relevant 3D panoramas, where it can have various contents – depending on the actions needed to be done.

2.1.9 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 a worker, and which needs to be executed at defined time. A running BIMERR reconstruction process is handled as a work order.

2.1.10 Provider

Providers are the users of the system. Every user can be assigned to different user roles (Figure 9). Each user role provides a set of permissions for the user that determines the functionalities accessible to the user.

Active role is displayed on the nav-bar under the user name (Figure 10). Users can switch their roles if there are more of them accessible to them.

After the first login, a I3D user is created, and the respective BIMERR credentials need to be assigned. The application allows users with roles Construction Worker, Construction Manager and Project Manager to log in and have access permissions within the system.

Figure 9 Navigation bar with active role

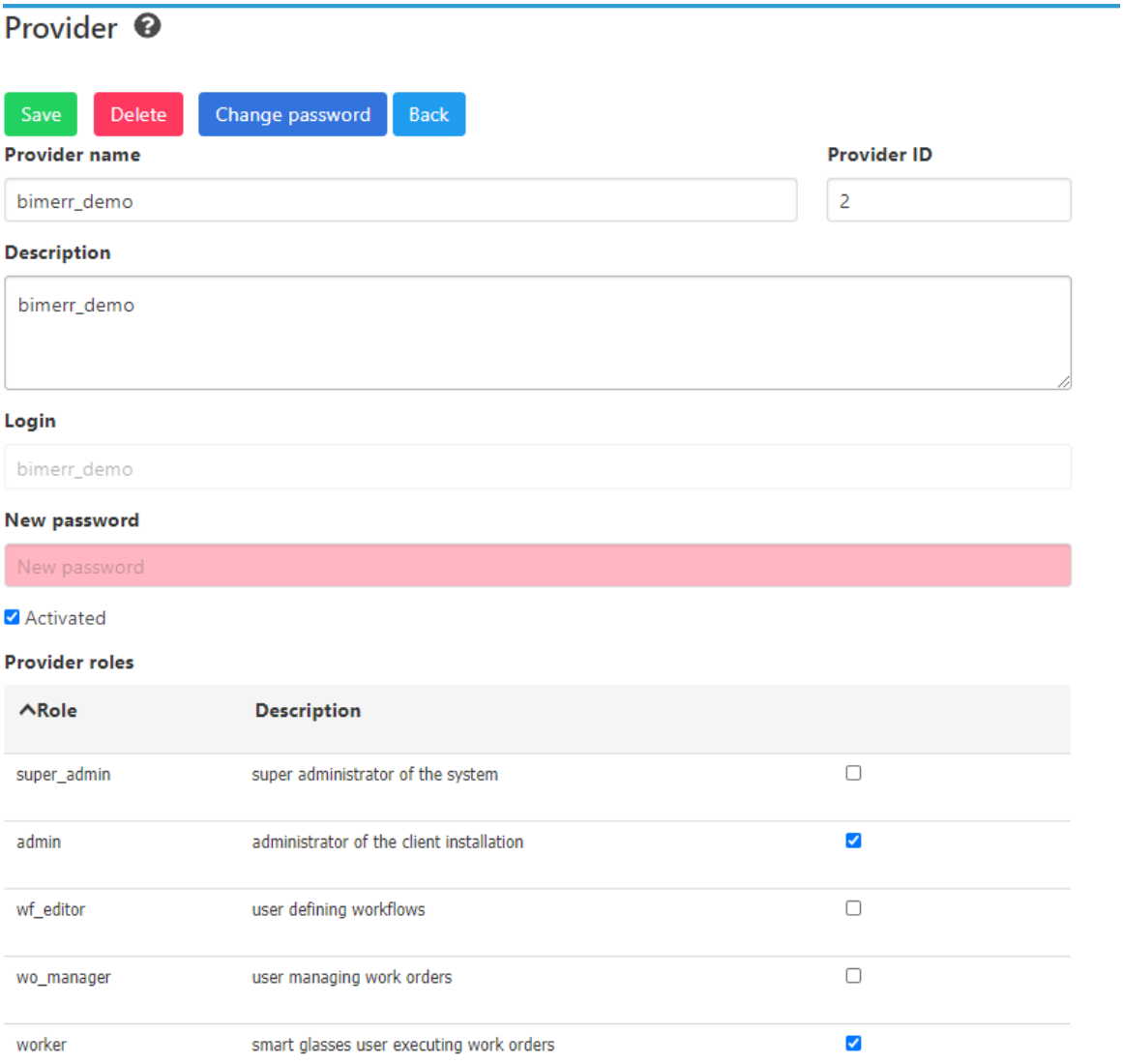

Figure 10 User management inside the I3D

2.2 WORKFLOW MANAGEMENT

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

Although, we expect that most of the work process templates will be defined in third party modelling tools and will be imported to the PWMA system, there is also the option to define a whole work process from scratch (Figure 11). This functionality can be useful in cases of a not typical project or non-typical components. We expect the utilization of this functionality also in cases where the imported work process template is not defined with enough granularity or does not contain all the expected information. The opportunity to modify the template can be useful also in cases when the standardized process needs to be adjusted to the characteristics of the reconstruction work.

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 also be a detailed 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.

2.2.1 Importing a BPMN file

The workflow execution engine is only part of the overall PWMA BIMERR toolset. It is important to ensure smooth cooperation of the workflow execution engine with other components of the PWMA toolset. To achieve this, the BPMN standard format has been selected to exchange process data between the components. An ETL tool which is parsing, transforming and importing data from BPMN to I3D has been developed and its functionality has been verified on the various example process templates, which have been produced in D6.3 “Adaptive Renovation Process & Workflow Models 2”.

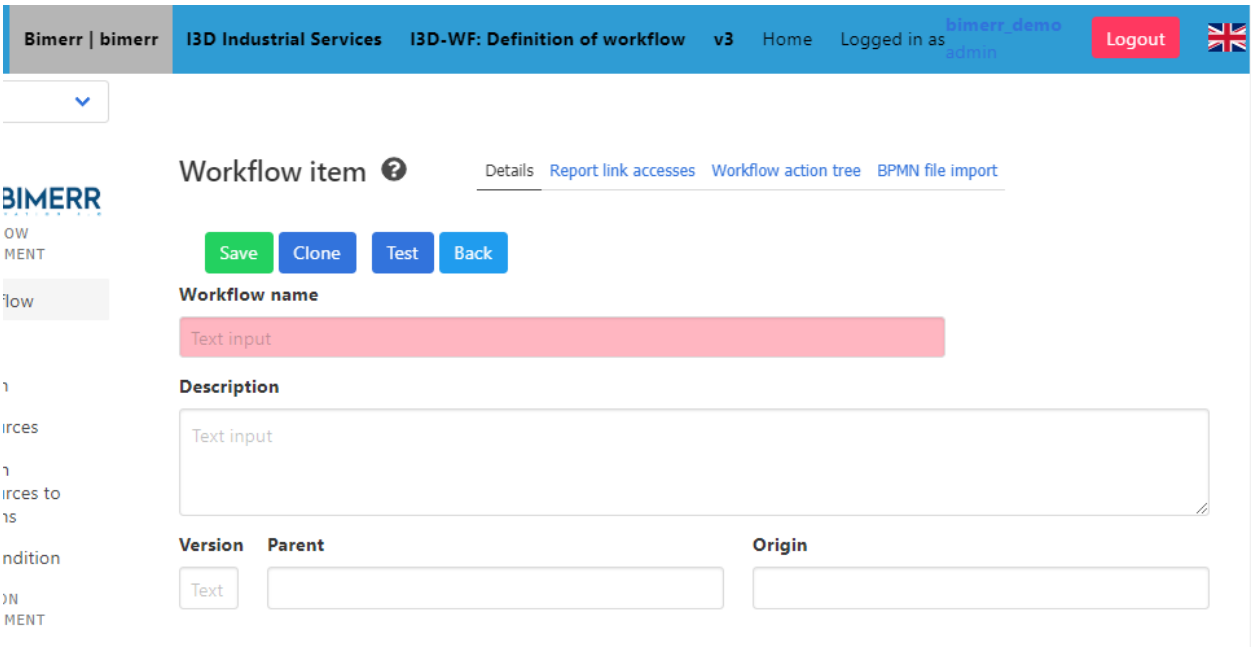

Figure 11 Creation of new workflow with option to load a BPMN file

In case, the same BPMN file is processed multiple times, every time a new version of the work process template is created in the I3D system (Figure 12). 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 managed outside the I3D.

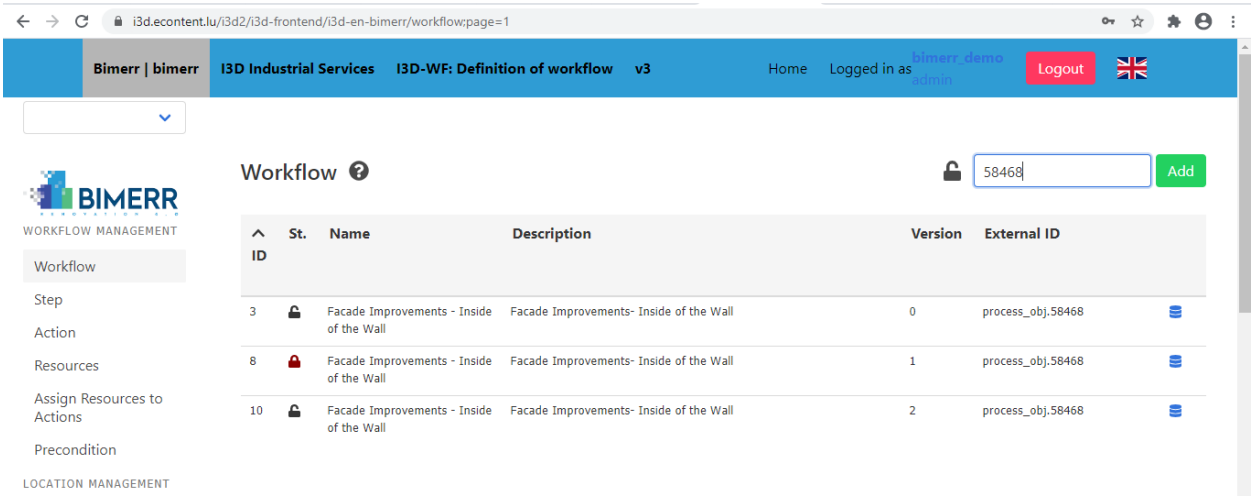

Figure 12 List of work process templates based on the BPMN with same external ID

The BPMN file contains almost all the information about the work process. It contains the sequence of tasks and their attributes. 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.

The attributes of the tasks are handled with special care, since the BPMN file contains not only task related attributes but also model related attributes. To not lose any valuable information, all the attributes are imported and handled as relevant. The project manager has the option to define, which attributes are needed to be displayed and which are needed to be hidden (Figure 13). In case of missing attributes, the Project manager can define his own ones, as well (Figure 14).

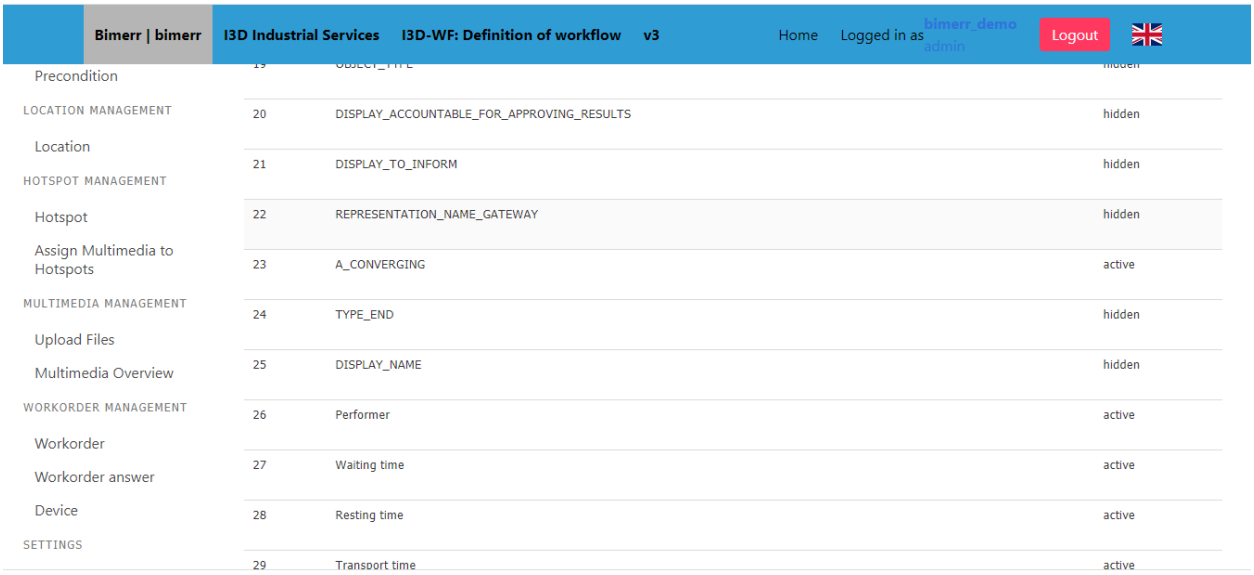

Figure 13 Management of attributes

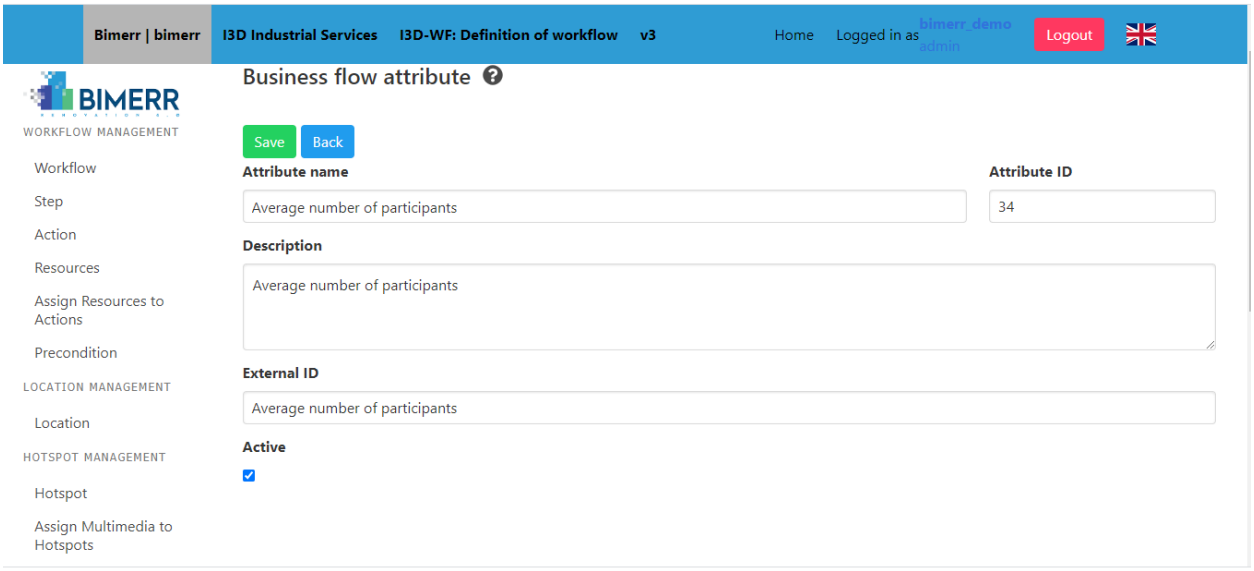

Figure 14 Task-based attribute evidence

In BPMN file we also accept service tasks which we can automatically execute. We implement http tasks defined by JSON data like shown on Figure 15. We implemented semi-automatic definitions of variables from the specific JSON, and automatic execution of service tasks when the work order is running.

```
{
  "url": "https://adoxx.org/micro-service-controller-rest/rest/msc/callMicroserviceForced
    ?microserviceId=76c014d7-328c-4907-a380-474ab5868746&operationId=sendMail",
  "method": "POST",
  "Content-Type": "application/json",
  "data": {
    "responsible": {
      "value": "_provide_here_the_modeler_mail_on_third_row_"
    },
    "deliverable": {
      "value": "_provide_here_the_midp_deliverable_field_on_third_row_"
    },
    "description": {
      "value": "Theactivityisbehindtimelimits."
    },
    "format": {
      "value": "_provide_here_the_midp_format_field_on_third_row_"
    },
    "filename": {
      "value": "_provide_here_the_midp_filename_field_on_third_row_"
    },
    "timelimit": {
      "value": "_provide_here_the_mpdp_date_limit_field_on_third_row_"
    }
  }
}
```

Figure 15 JSON of mail service task from the imported BPMN file

Import from BPMN file can also contain Time exceeded boundaries – events triggered when the defined time exceeds (Figure 16) the actual time of work. Intermediate Catch Event can be used to add an option of repeated action loops (Figure 17).

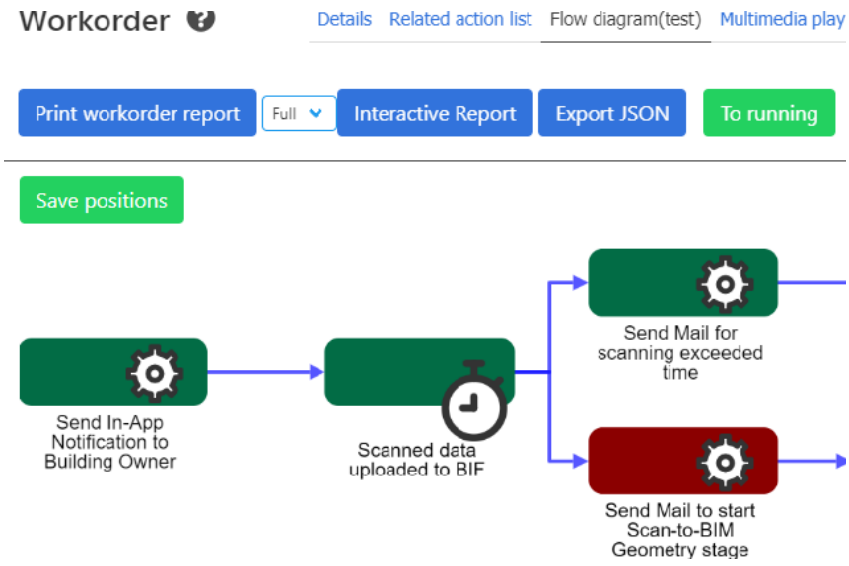

Figure 16 Service tasks and time exceed branching

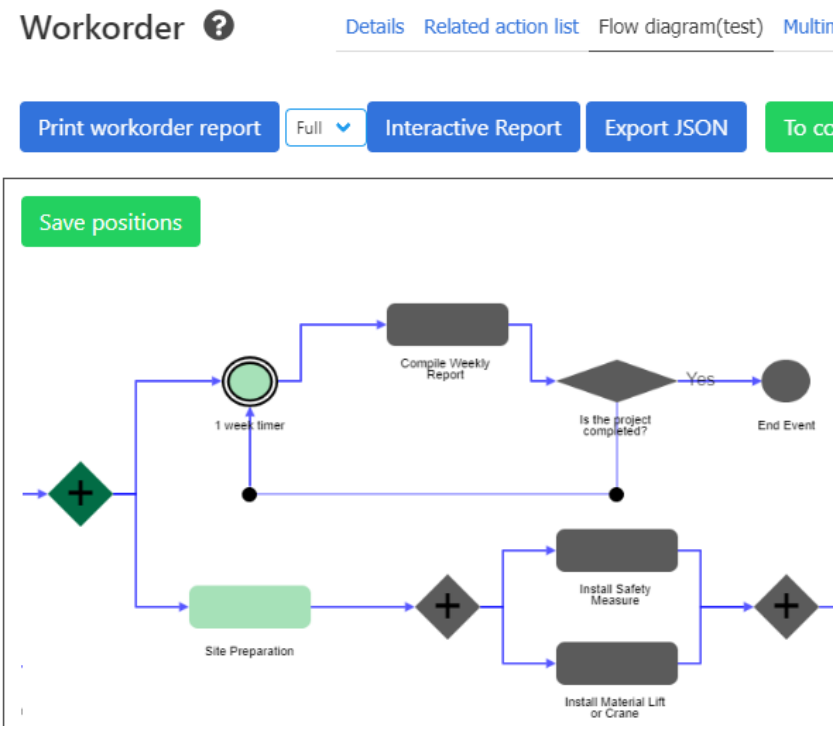

Figure 17 Cyclic repetition of weekly report with timer

2.3 DIGITAL TWIN CREATION

2.3.1 Creation of the digital twin

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.

In the moment of creation of a digital twin, the exact work process template is processed, and an empty process log is created, which contains only the planned values of attributes (Figure 19).

Before the process of creations is started, the planned starting date and planned finish date are set. Every work order has its main provider as main worker and work order owner, who is the manager for this work. If there are more roles/process lanes imported, it is possible to assign every line to other worker (Figure 18).

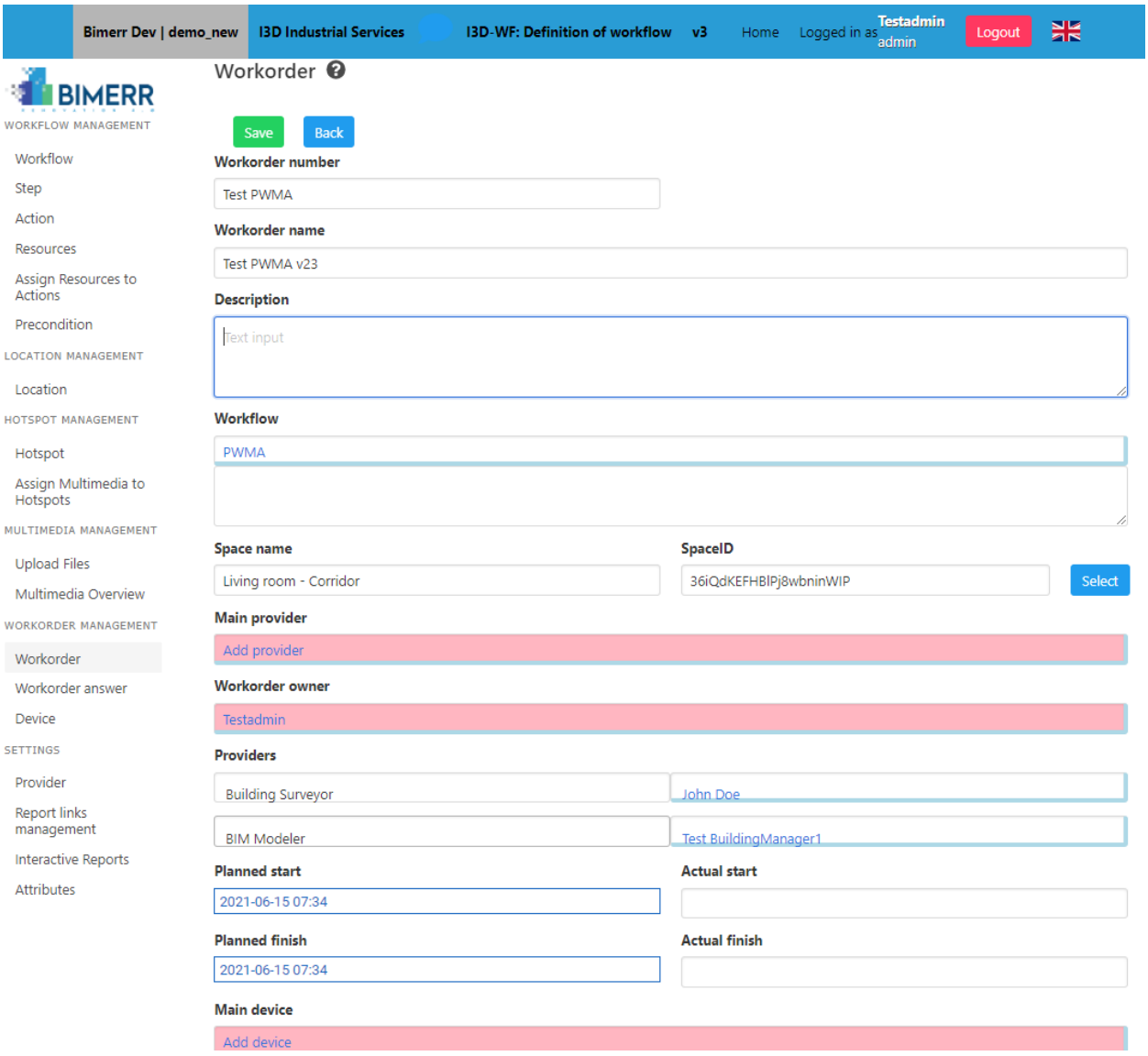

Figure 18 Creation of a work order - digital twin

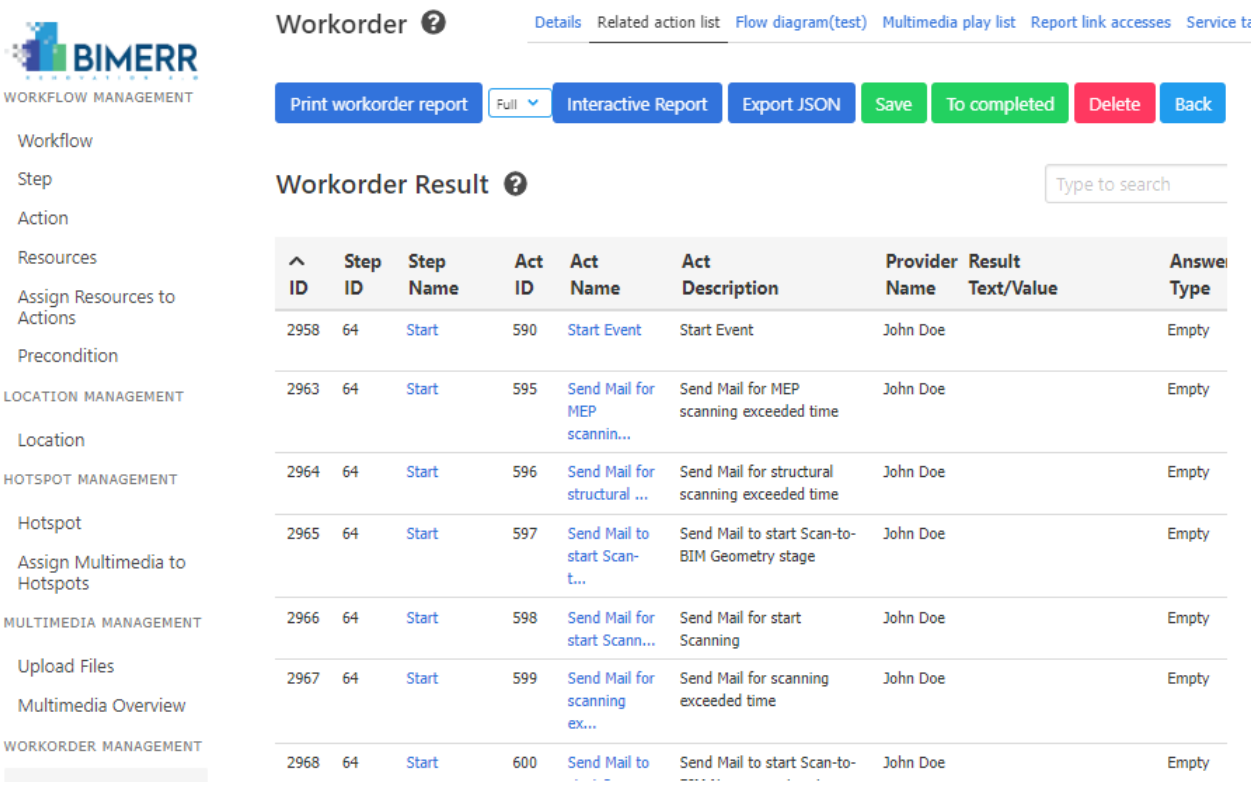

Figure 19 Empty process log created

2.3.2 Changes to digital twin before running

After creating work order, manager should switch to flow diagram and fill schedule for tasks, task attributes, and Health & Safety (H&S) issues for all tasks (Figure 21).

2.3.3 Service task attributes management

Some workorders contain one or more service tasks with attributes that are essential to process the respective tasks. The authors of the respective workorders need to fill in those attributes (i.e., worker's e-mail address, which was not previously defined). All values must be committed before work order starts (Figure 20).

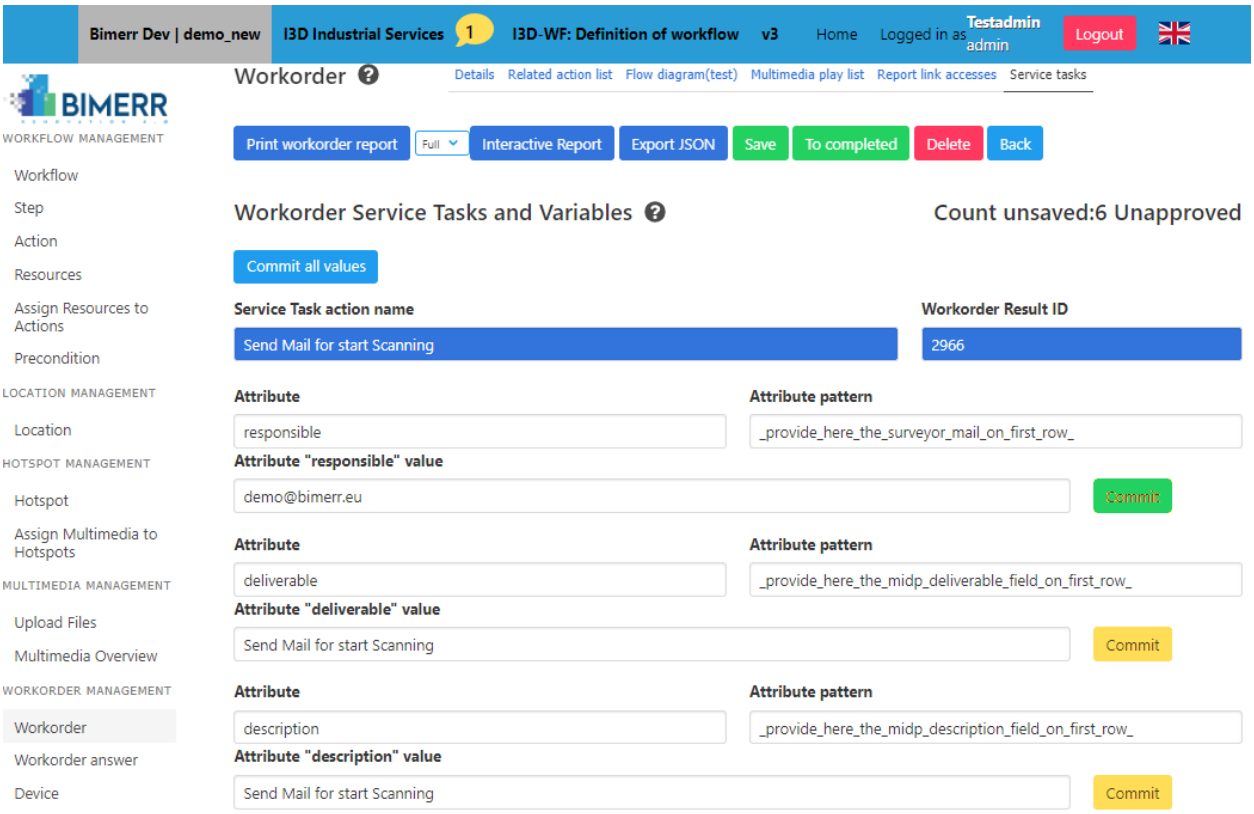

Figure 20 Service tasks variables to fill

2.4 DIGITAL TWIN MONITORING AND MANAGEMENT

The I3D provides different User Interfaces (UI) via which the work order can be managed. The most important are the (a) web-based interface – Execution Engine, which is supposed to be used by the project manager, and (b) the application for on-site workers, which can be used on mobile and wearable devices, like smart glasses, cell phones and tablets.

Both of UIs provide different set of tools and opportunities to do interactions with the work orders. The web-based UI focuses more on administrative users, like project managers. The application for on-site is intended to be used by workers, foreman, quality controllers and other users on-site.

The web-based UI contains a graphical visualization of the work order (Figure 21). This provides a quick overview for the user about the overall status of the reconstruction process. The statuses of the tasks are visualized in green, red and grey colors, to indicate which tasks have been executed correctly and which not. By clicking on the elements in the flow diagram, the details of the task are displayed. Via this detail view, the user is allowed to change the

details of the task in terms of changing the status of the action, reschedule it, recording its attributes, setting H&S issues, and assigning sub-tasks.

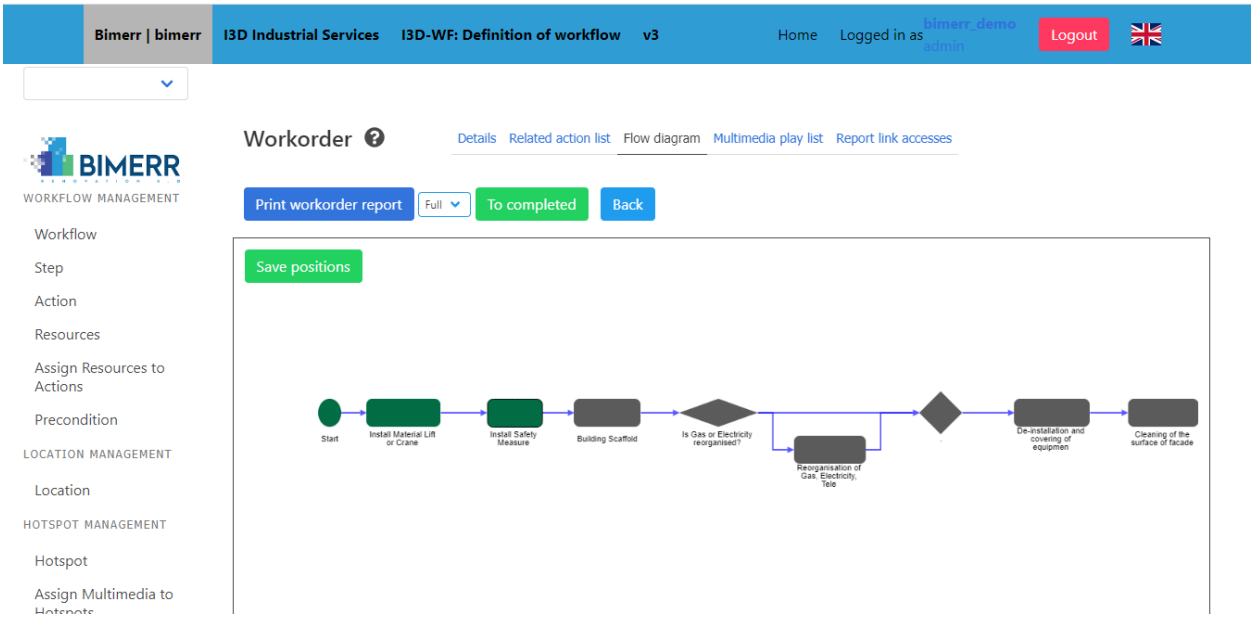

Figure 21 Visualization of the running work order

The project manager is allowed to re-plan the work order in terms of defining the planned starting and ending date and time for every ongoing task and to set the real starting and real ending for each task, including the status of every task (Figure 21). For the work orders that have not been started yet, the main provider can be replaced, and the task marked as completed can by re-opened or re-issued by the project manager in case of need.

Manager of workflow can also change worker of the particular task. Notification about the change will be sent to previous worker and to the new one.

Manager can also affect workorder task status by executing tasks by changing their result status.

Other important way of interaction with the work order is the attributes management (Figure 22). Attributes contains KPI data defined and recorded on task level. For every task of the work process, the project manager can display the list of planned attributes defined in the work process template (e.g. imported from BPMN), can define their own planned attributes as well as can record the real attributes, like cost, duration, used resources, etc. (Figure 23).

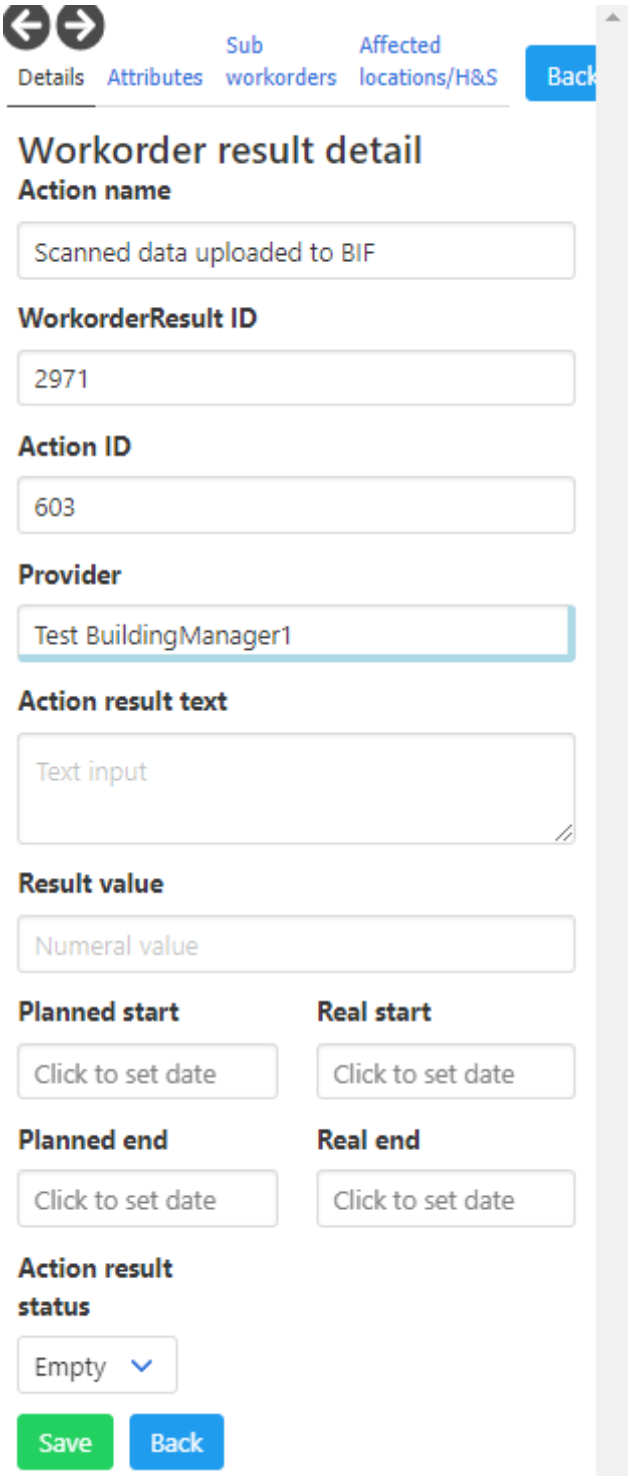

Figure 22 Rescheduling the task

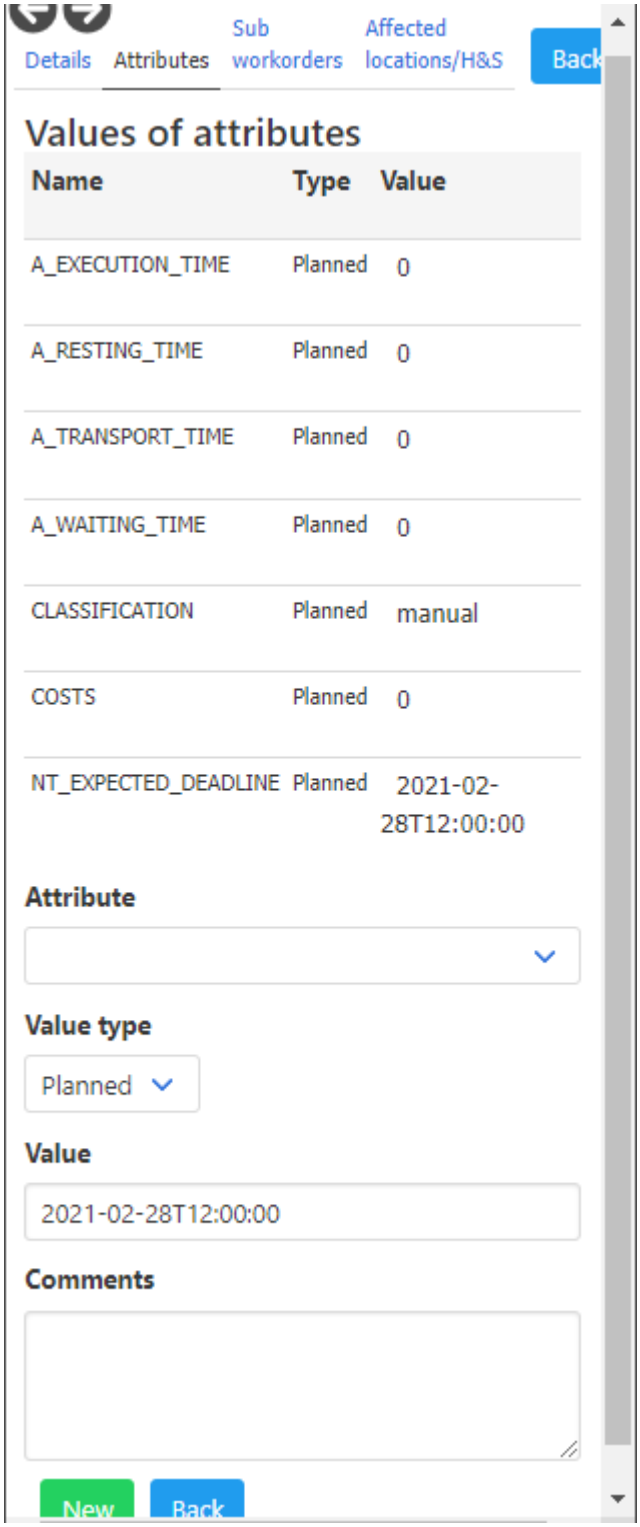

Figure 23 Rescheduling the task

The project manager has different options to extend the work order. The portal allows to assign one or more existing or new work orders as sub-work orders of the running work order (Figure 24). In this way, the project manager can define the tasks with higher granularity and more exact instructions. These sub-work orders are created in the same way as the main work order, and the work process templates are utilized for doing so.

This is also a way in which the manager can add new tasks to a running workorder. Create new simple workorder and put it as a sub-workorder for the task of the main one.

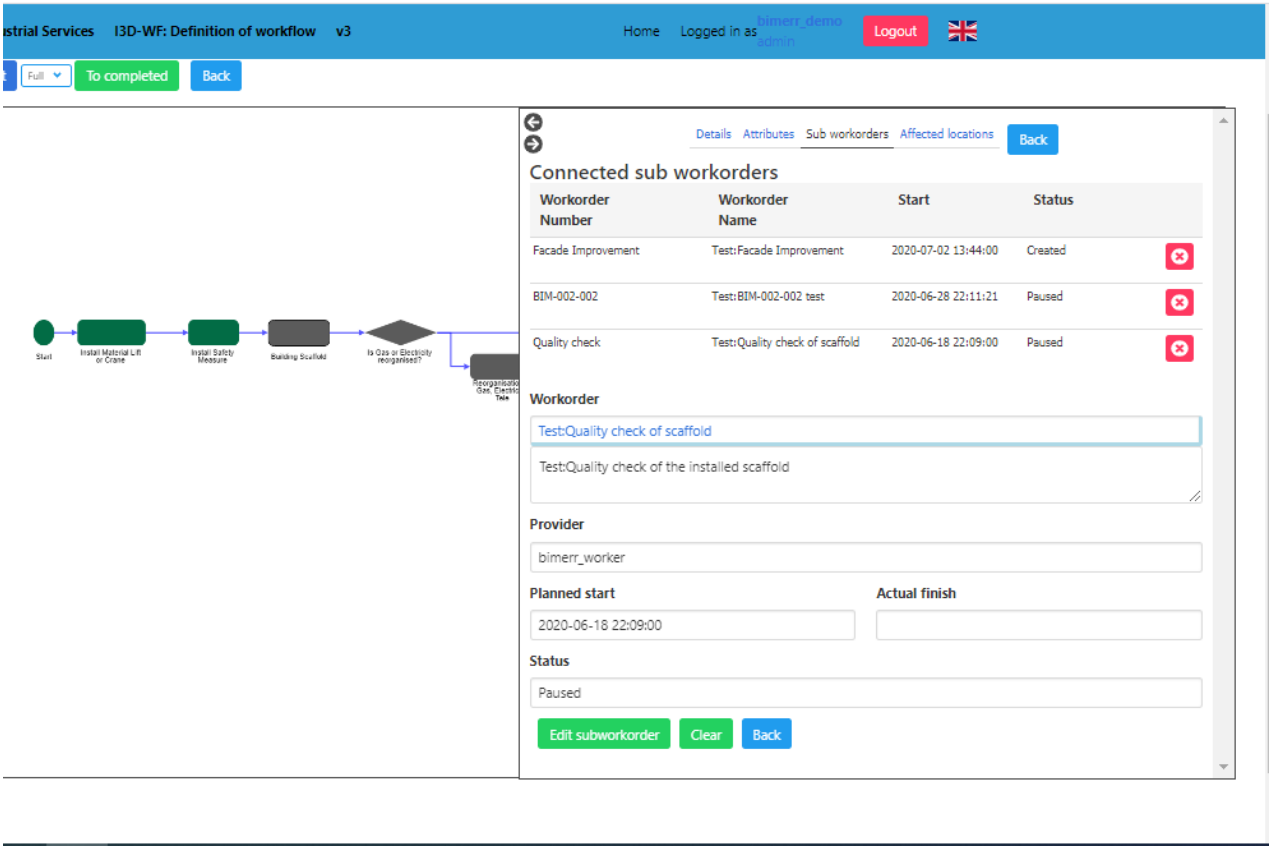

Figure 24 Assignment of sub-work orders to a task of the main work order

One of the key requirements set on the workflow execution engine is to transparently inform all the stakeholders about the status of the reconstruction and its processes including the potential Health & Safety issues (H&S) related to the on-going tasks. We have 6 predefined H&S issue types: Electricity cut, Noise warning, Dust warning, Water cut, Gas cut, Telecommunication error.

Notifications are defined for spaces separately, so if a particular work on a task affects several locations, the H&S can be defined for all of them. The application provides an option to choose two notifications for every H&S issue. On Figure 25 we have notification on task planned to 1.6.2021 8:00, the first notification triggers 2 days before the task starts and is repeated one hour before the start.

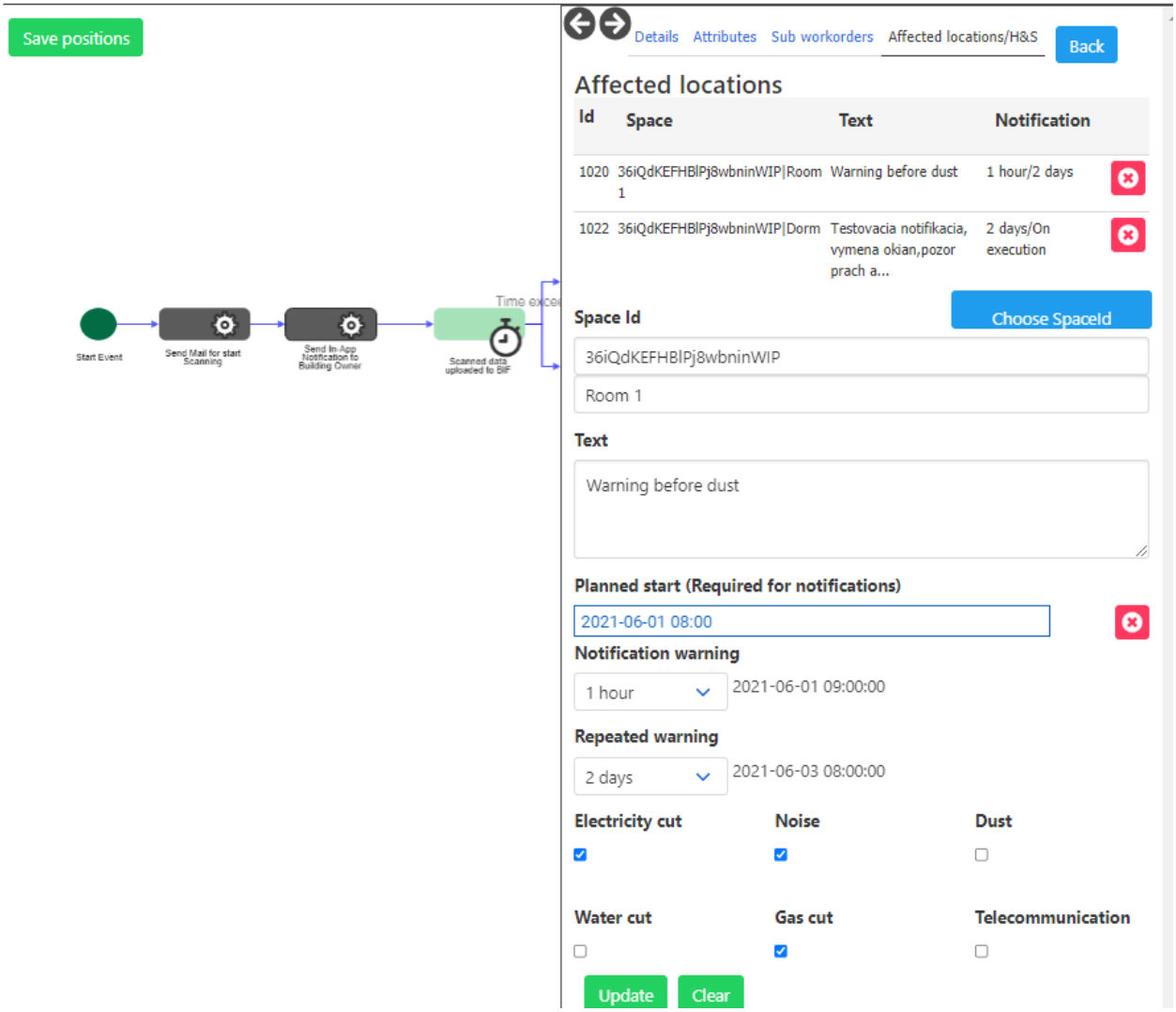

Figure 25 Indication of locations affected by the tasks of the reconstruction

Every work order can be managed also via the application for mobile devices. The user of the application has always up-to-date view of all the work orders assigned to him (Figure 26). Once the work order execution has been started, the application provides step-by-step, action-by-action guidance for the worker trough the work order. The beginning of the execution of every action is confirmed by the user (Figure 27). During the execution, the

application is automatically changing the status of the started task, calculating the duration and after finishing the execution, the worker is forced to report the status of the task (Figure 28). In case the worker needs to collect some data, an input field to collect the data attached to the task appears. For every task, the worker can attach several multimedia files as evidence and proof of properly executed task (Figure 29). The application for on-site support of the workers is described in more detail in the Deliverable D6.9 "Smart glass application for on-site renovation worker support 2".

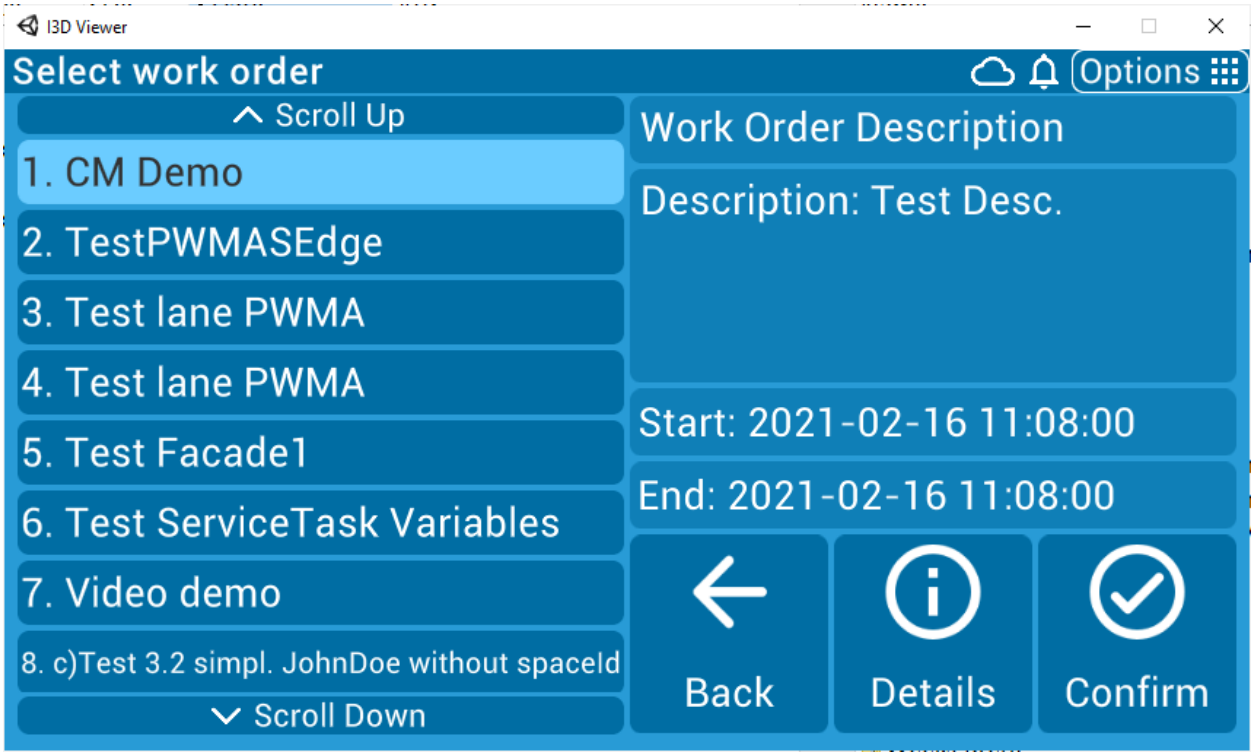

Figure 26 List of work orders assigned to the user displayed in the application for a mobile device

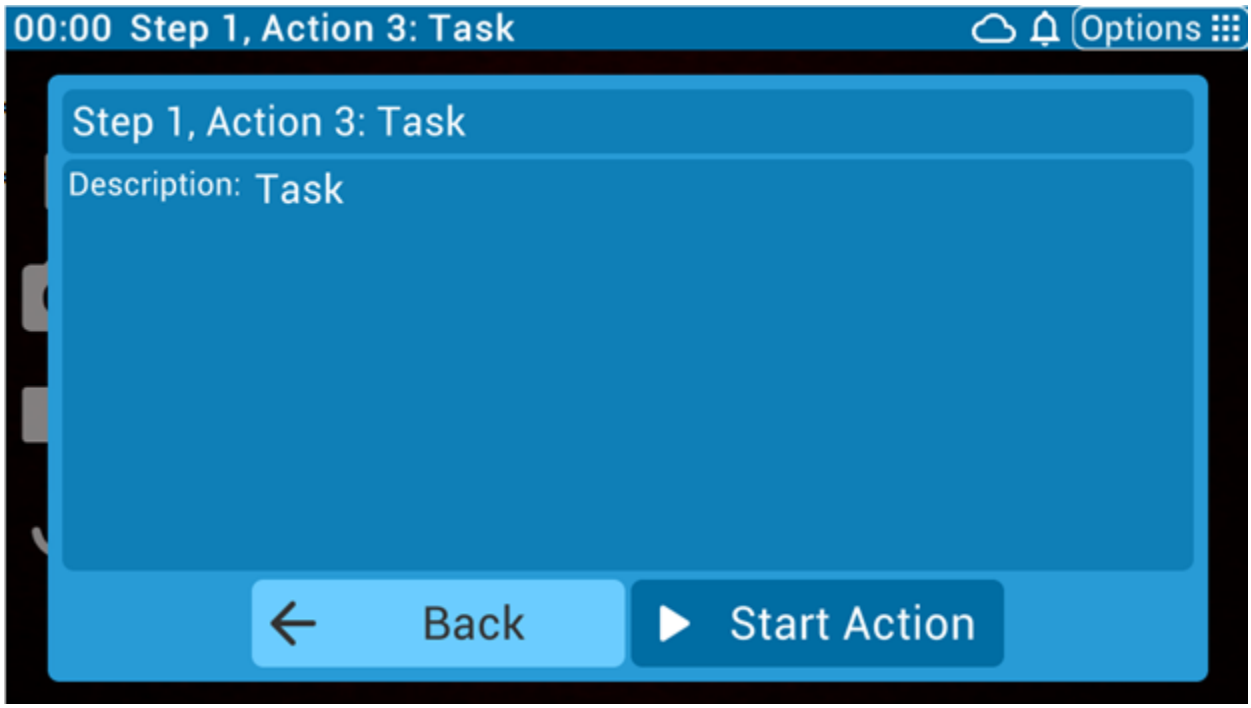

Figure 27 Starting the execution of a task in the app for mobile devices

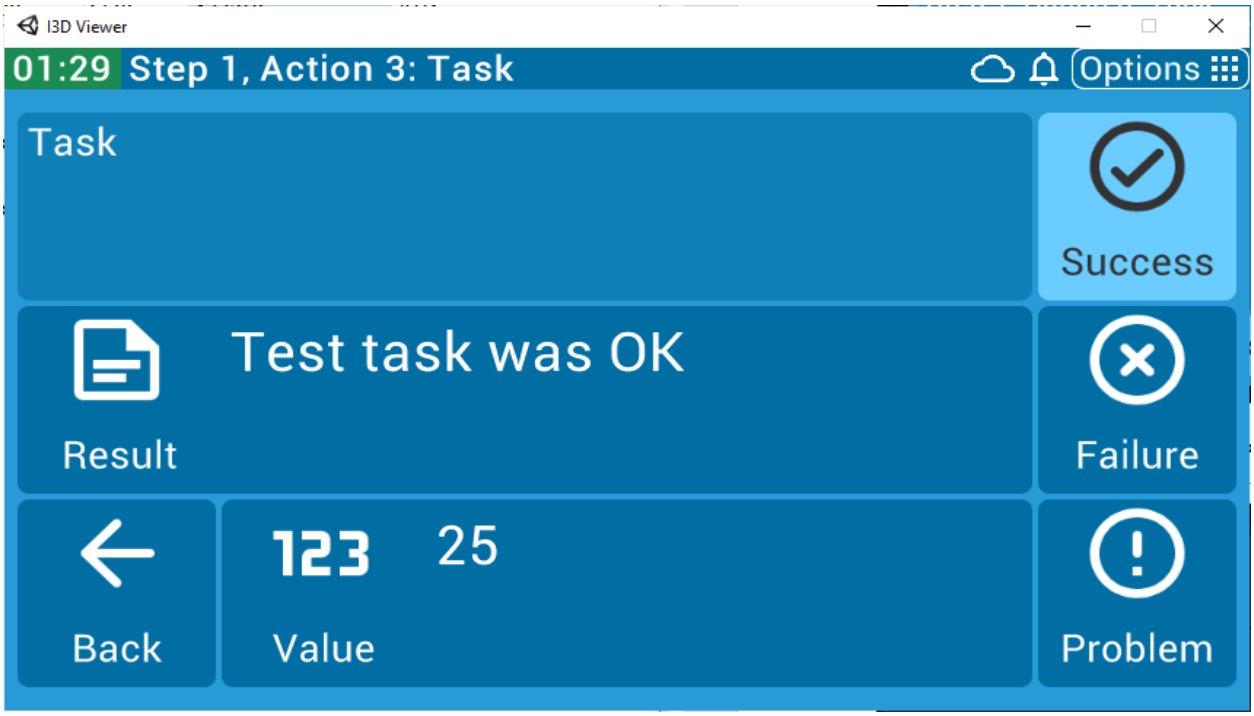

Figure 28 Confirmation of the successful execution of a task via the app for mobile devices

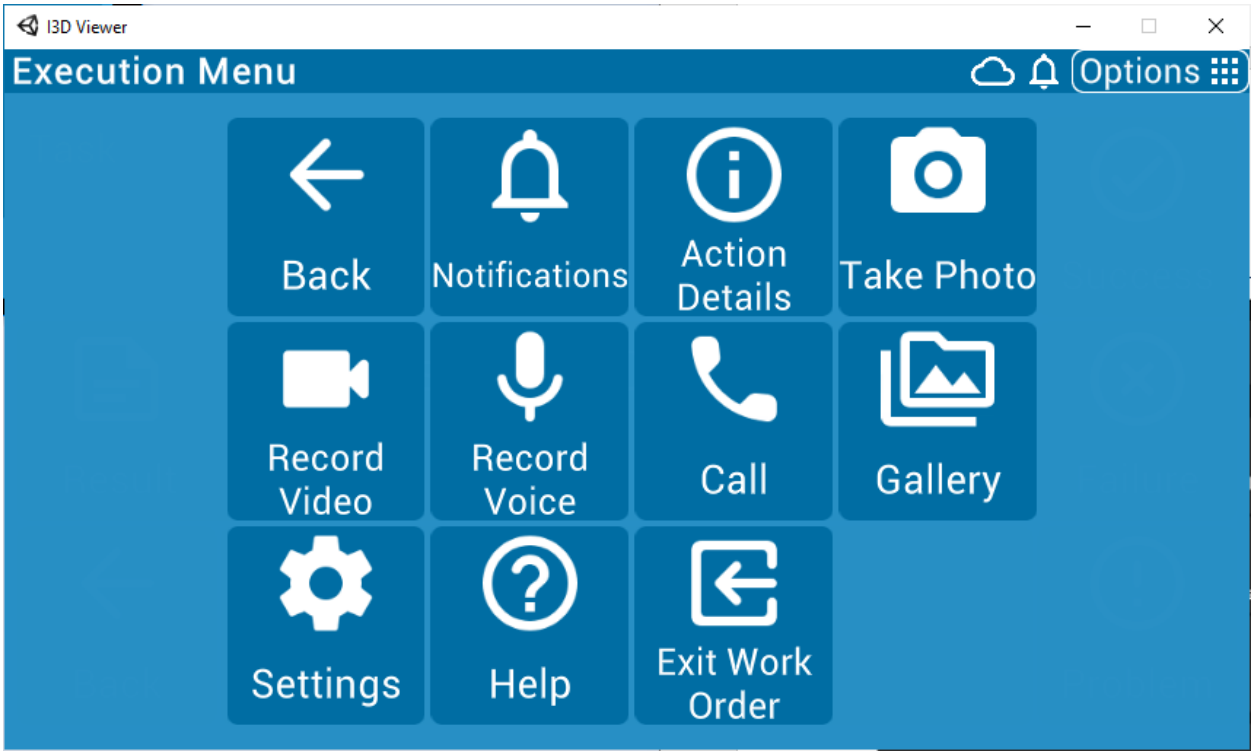

Figure 29 Tool set available for the worker in the app for mobile devices

2.5 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 final 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 30). The second REST API endpoint provides detail data about a digital twin with all the data related to the selected work order (Figure 31). This process log is in form of

structured JSON, which makes it easy for other component to process and extract the data needed.


```
[
  {
    "workflow": {
      "header": {
        "id": 1,
        "name": "Facade Improvements - Outside of the Wal",
        "building_id": 379930,
        "project_id": "process_obj.58134"
      },
      "workorders": [
        {
          "header": {
            "id": 1,
            "name": "Test:BIMERR RECONSTRUCTION 001",
            "description": "Test:Facade Improvement Template",
            "start": {
              "planned_start": "2020-06-18 22:00:00",
              "actual_start": null
            },
            "finish": {
              "planned_finish": "2020-09-18 22:00:00",
              "actual_finish": null
            }
          },
          "tasks": [
            {
              "id": 1,
              "name": "Start",
              "description": "obj.58004| Start for Start",
              "execution_time": {
                "planned": {
                  "id": 51,
```


Figure 30 REST API output - JSON with a list of work orders created from a selected work process template

Figure 31 REST API output - JSON with process log of the selected work order

2.6 PUSH NOTIFICATION SYSTEM

Discussions about the architecture and interaction between several components of the PWMA raised the need for a push notification system, which will provide the opportunity to inform all the relevant stakeholders about all events in which they are interested in. Notifications are integral part of the PWMA Execution engine web application and part of the PWMA application for on-site workers as well.

During development of notification system, we also created web application to manage notifications and access policy.

2.6.1 Overview of the notification system

We use notifications as a communication channel between users, between the system and users, or between the system and residents.

Notifications are generally used to send message from worker to manager and vice versa.

Another use is to carry messages from system. System automatically place notification to workers and managers about various changes e.g., change of worker on task, work order start, finish or H&S issue.

The last use is a creation of Health & Safety notifications and communication with an application *PWMA for residents*.

2.6.2 Notification system taxonomy

Notification: Message user or group can be subscribed to.

Priority: Messages can have priority Default, Warning, Urgent and Health and Safety

H&S category: There are six H&S categories, that can be set to H&S notification: Electricity cut, Noise, Dust, Water cut, Gas cut, Telecommunication.

Group: Every user can be member of one or more notification groups. Every user has notification group to his own, where he is subscribed automatically. There are also groups created for users involved in particular work orders. However, manager can create group, assign users and send notifications to them.

User group: Group of users.

2.6.3 Notification system for workers

Notification system is integral part of the PWMA on-site support app. When working, user can receive notification, which is displayed on top of the app (Figure 32).

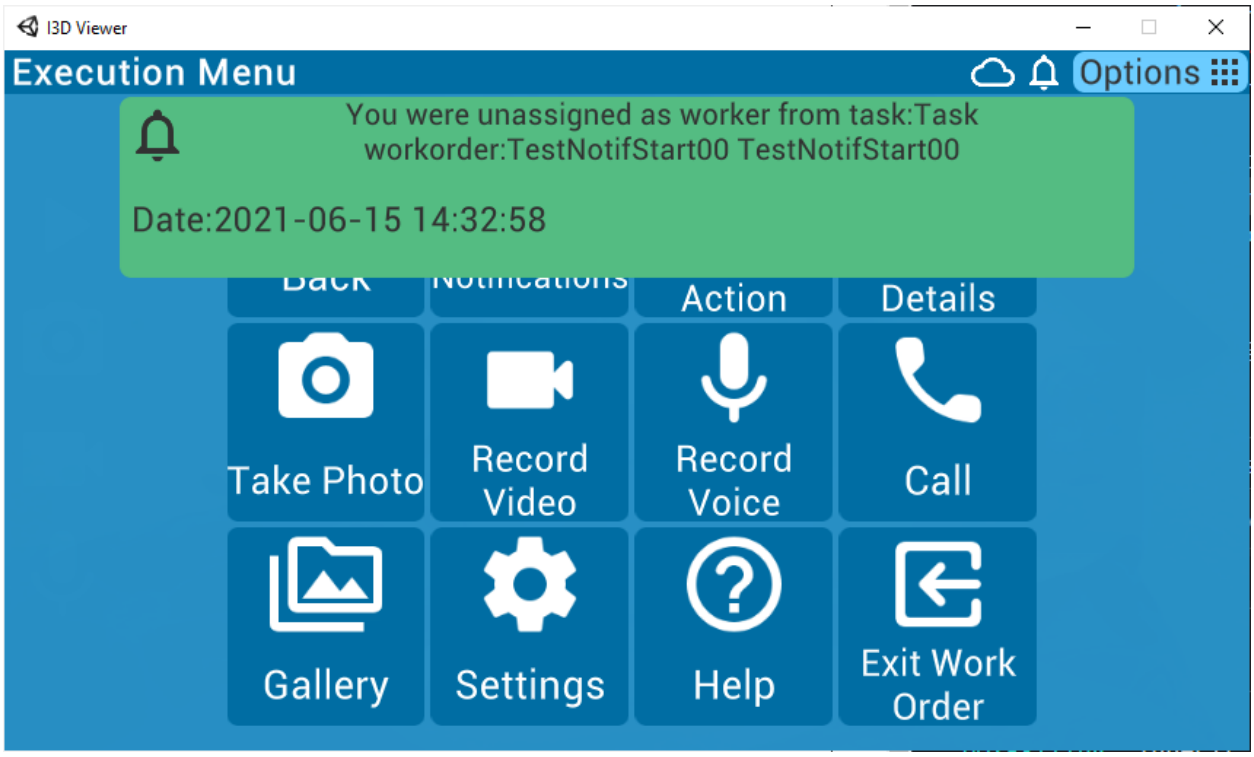

Figure 32 PWMA on-site support app - active

Worker can also list his recent notifications by pressing Options menu and panel Notifications. (Figure 33) He can also send notification to workorder manager or other users as well. He can send a message where title is the workorder he is currently working on. Then he chooses priority and eventually H&S issue (Figure 34, Figure 35).

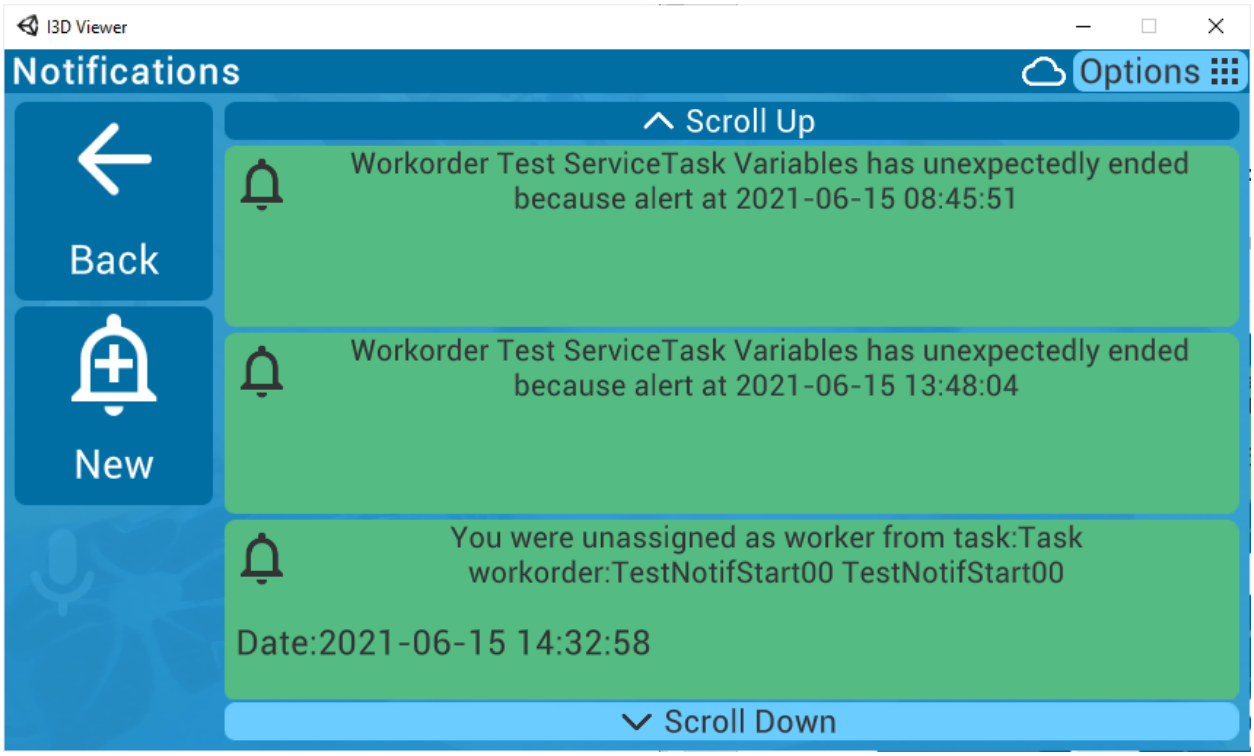

Figure 33 PWMA on-site support app - notification list

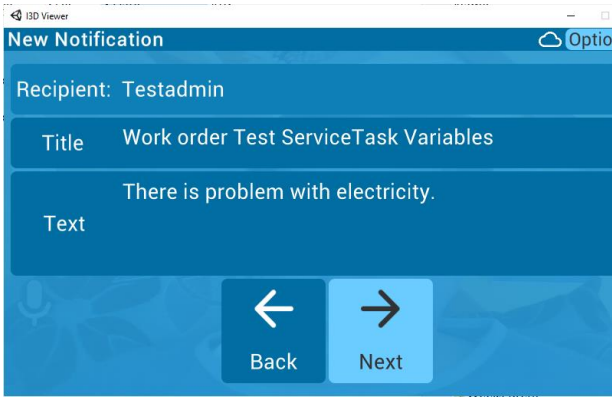

Figure 34 Notification create

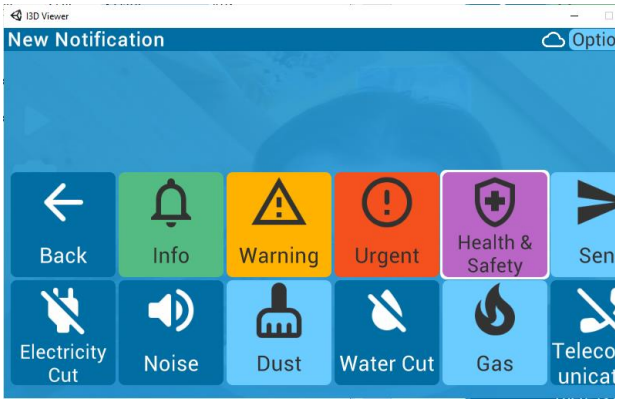

Figure 35 Notification priority and H&S

2.6.4 Notification system for manager

Notification web app was created to manage notifications preferably by manager. Worker can also use the application, but they have only access to home page with their own notifications (Figure 36).

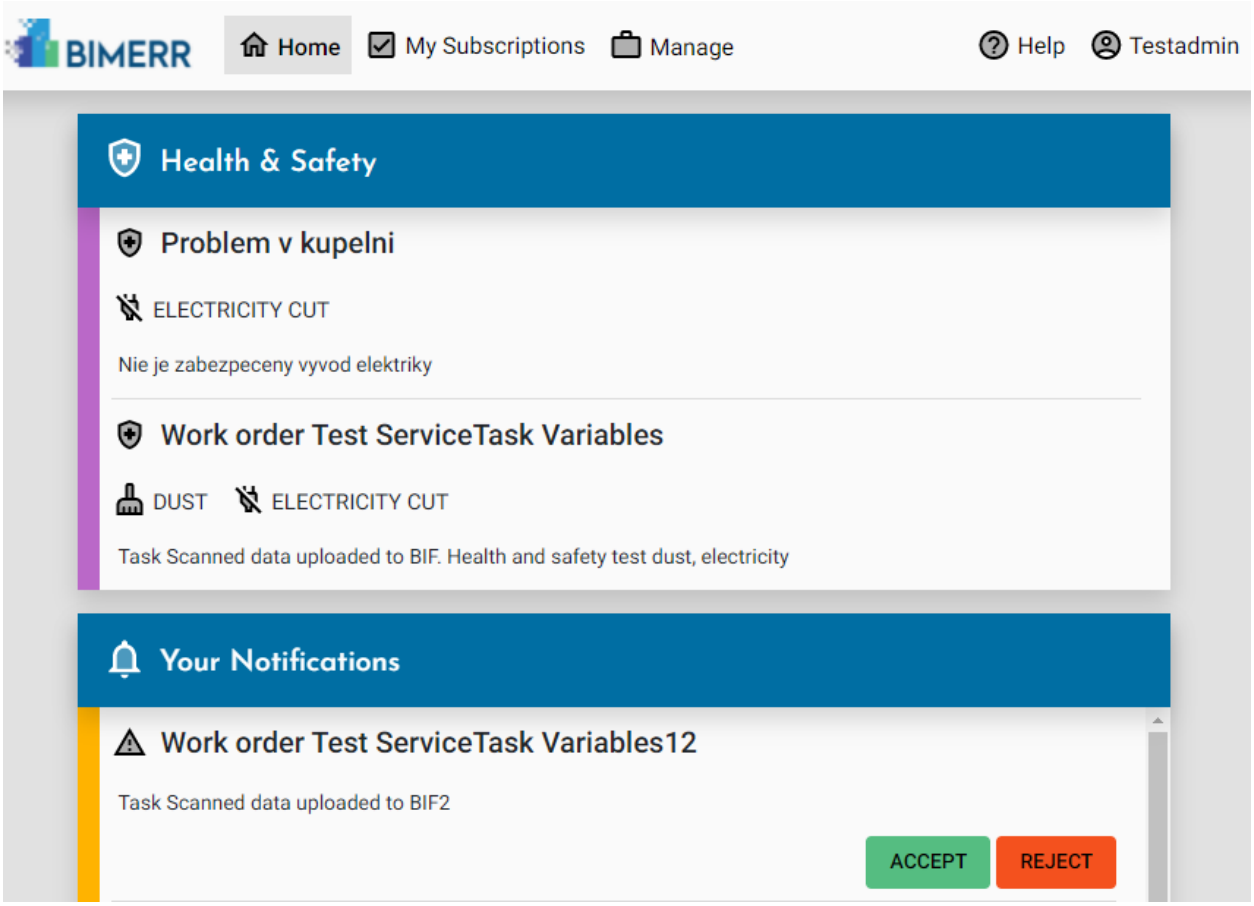

Figure 36 Notification app - home page - notifications

User with manager rights has access to menu Manage, which allows to create notifications, to create and administrate user groups and to manage subscriptions.

On tab Manage/Users (Figure 37) manager can see user list and can see user groups. He can eventually create group of users to his own purpose.

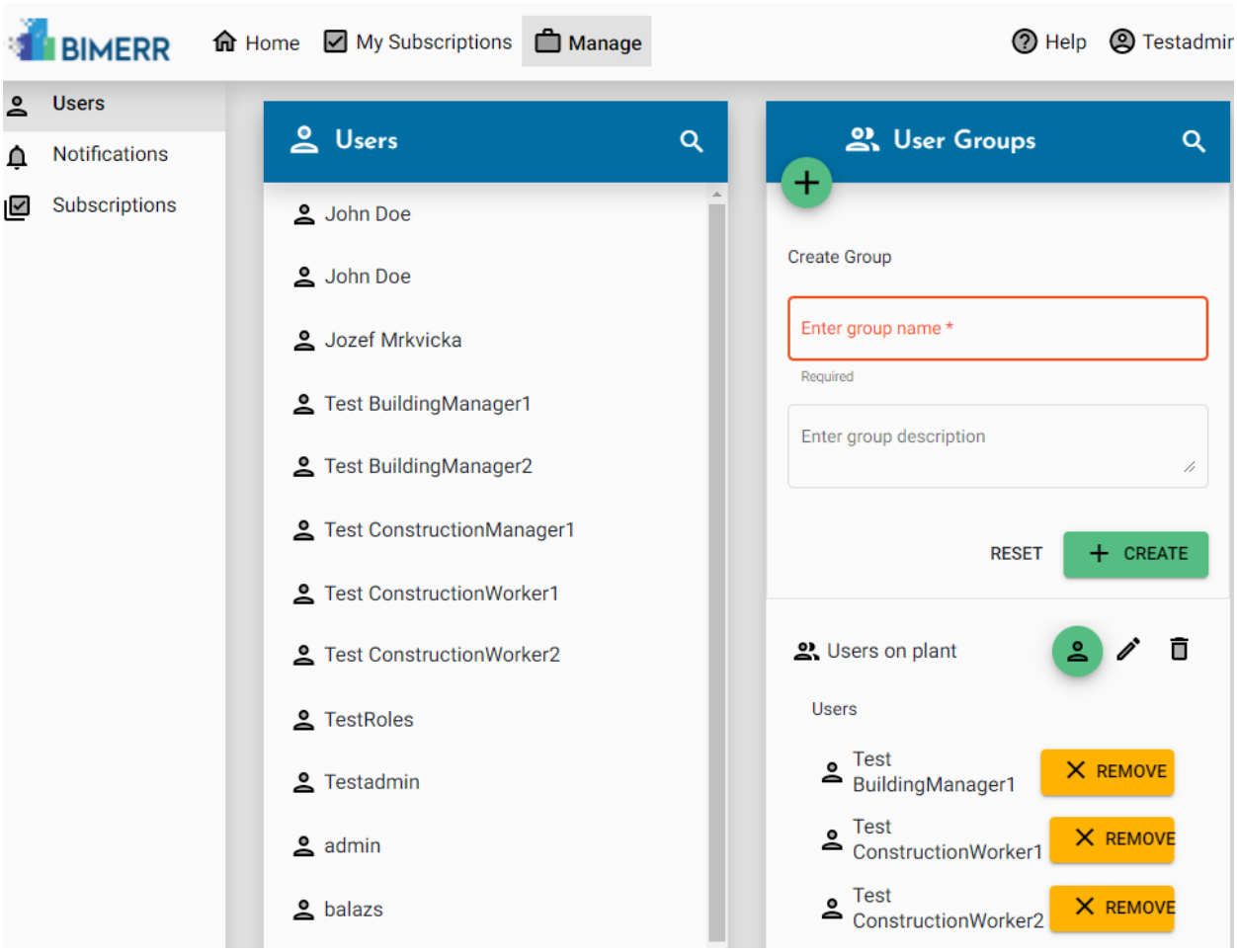

Figure 37 Notification app manage users

On page Manage/Notification (Figure 38) manager can work with notifications. He/she can see and create notifications by clicking on icon "+" and then filling respective data. If he/she changes priority to Health and safety, he/she can choose H&S category. Only active notifications are visible to workers. Once notification is created, manager needs to address notification. On the right side there are notification groups. Every user has his personal notification group, he is automatically subscribed to. There exists also notification group for workorders and manually created ones. User shall find respective group and click the bell icon. Then he/she can drag notification and drop it onto notification group. All subscribers of group will get the notification.

On page Manage/Subscriptions manager can manage notification groups (Figure 39). He can not manage user groups. He/she can add/remove users subscribed in notification group by clicking on check icon. He/she can also directly subscribe user to notification by dragging

user/user group to notification. Most of notifications in the PWMA are directed to some user notification group.

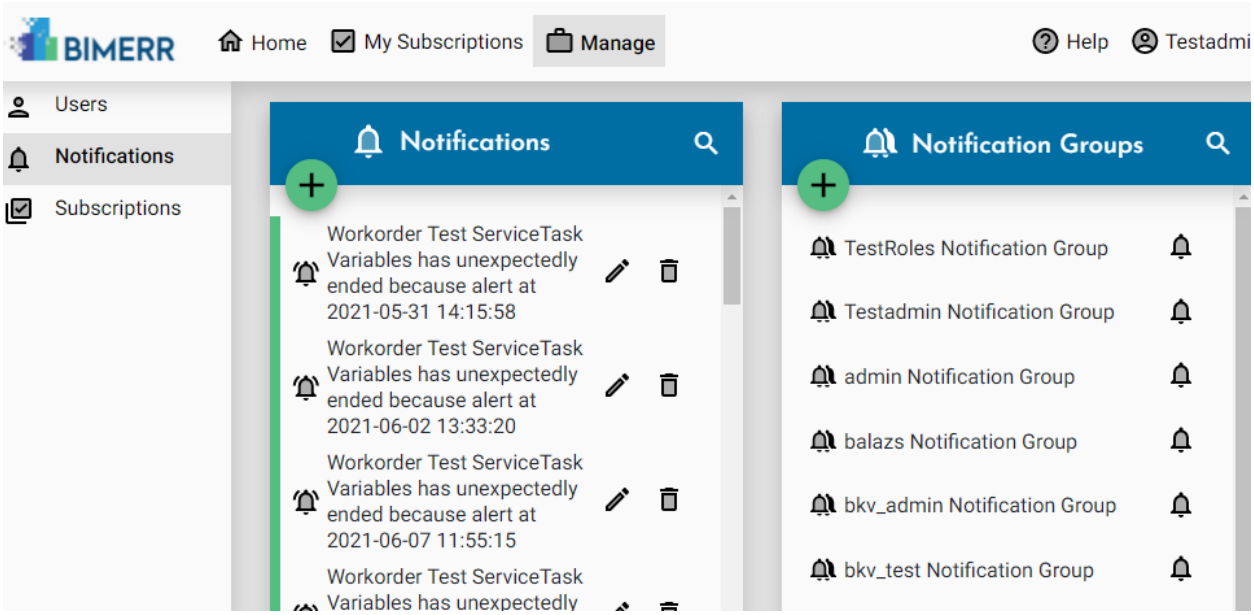

Figure 38 Notification app manage notifications

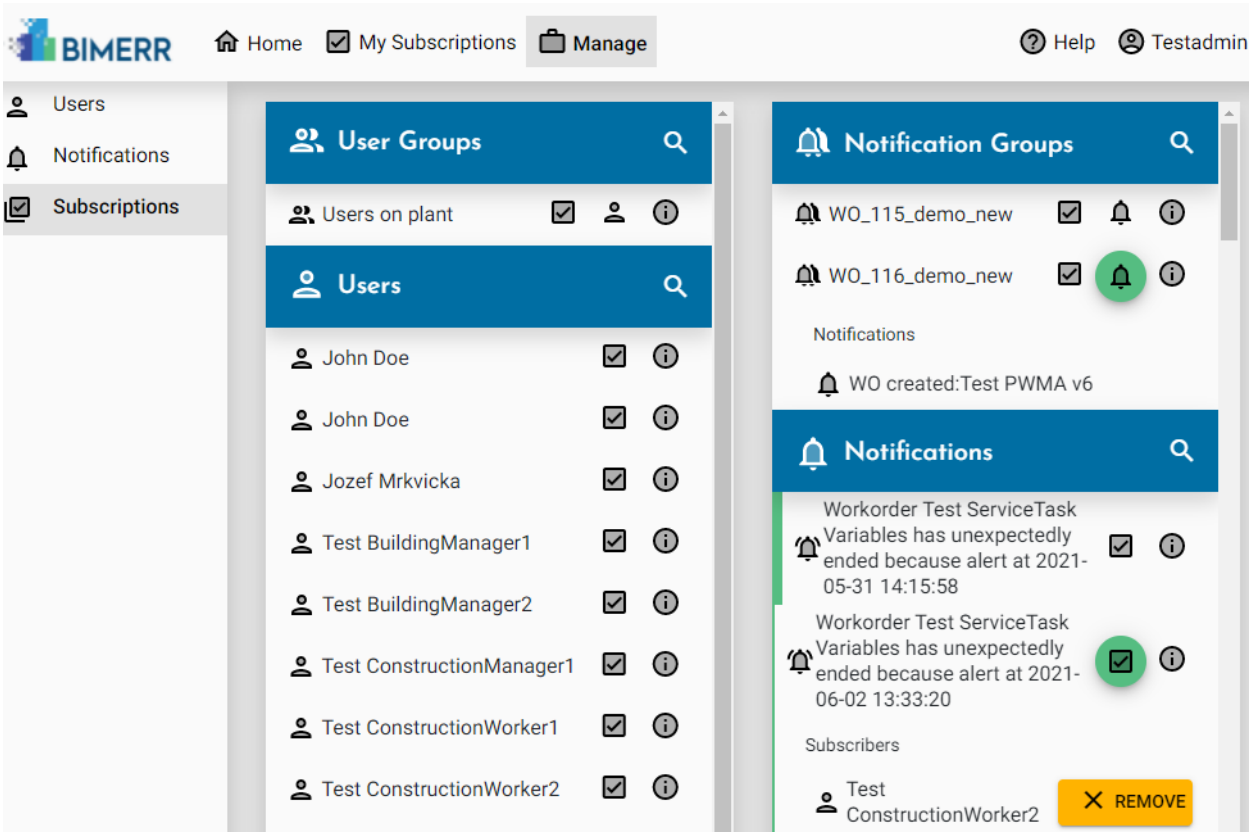

Figure 39 Notification app manage subscriptions

Manager, when primarily working with the PWMA Execution engine – web app, is connected to notifications and receive notifications online. Last incoming notification is displayed under navigation bar and on navigation bar there is message icon with number of received notifications (Figure 40). The user can also click on icon of message and read all user's notification by clicking on a button Load all notifications or open Notification web app by clicking on the button Open notification app (Figure 41).

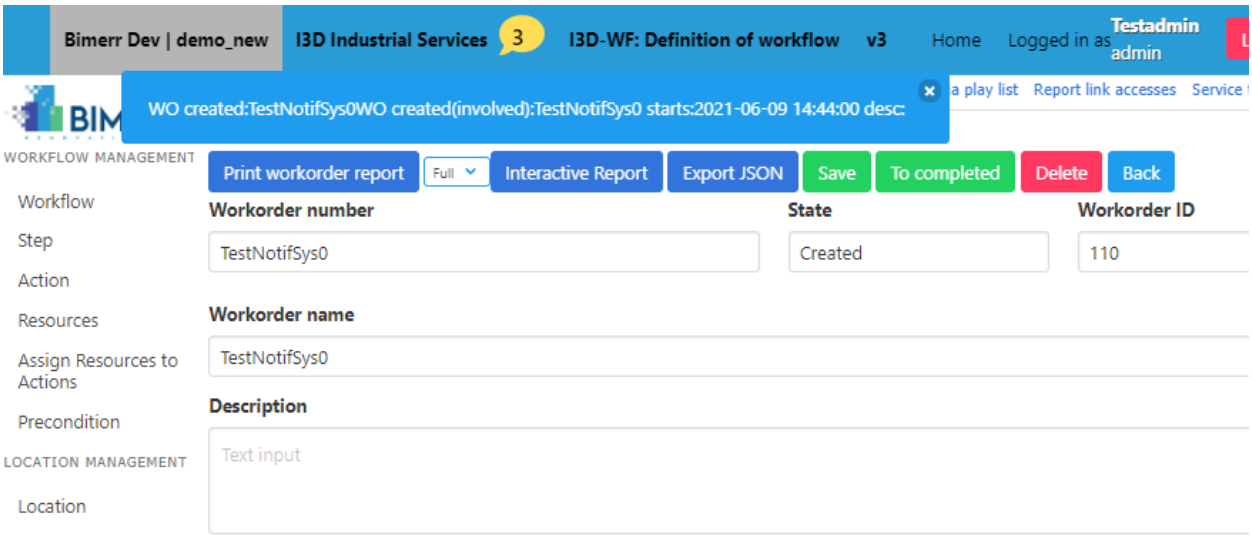

Figure 40 PWMA web app - received notification

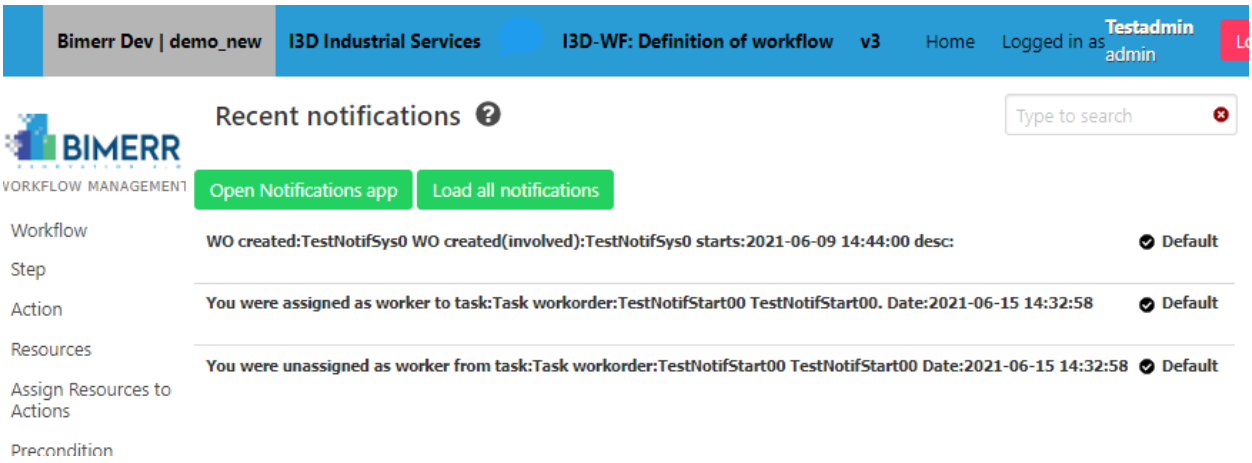

Figure 41 PWMA web app - notifications page

2.7 WALKTHROUGH

Generally, PWMA Execution Engine is primarily used by project managers and construction managers.

First role of PWMA execution engine is to create workorders. Manager gets process model which is created in an application Design tool for Renovation process. In the PWMA Execution engine the manager gets it as import of an BPMN file. This is done via automated endpoint in backend of the PWMA. After importing of the BPMN file, we pass it through an

ETL tool, which is parsing, transforming, and loading data to create workflow - model of the process.

Import of BPMN file can also be done manually or created step-by-step.

Manager can control and eventually modify the digital twin model, and then he /she need to approve model before creating work orders from it.

Construction manager is then able to create a workorder – a digital twin of the process. The manager chooses which process to use and assign the main provider (worker) for workorder. If there are more lanes/workers defined in the workflow, they must add a provider for each of the roles. They then set the workorder's name, planned start, and end of work.

If the workorder has any defined service tasks, the manager is shown a page where they need to fill in all variables to process the service tasks correctly.

The manager can now switch to detail of the workorder and to flow diagram to add necessary information and set task's planned start and end. They can add sub-workorders if necessary or can add Health and Safety issues connected to the task. The workorder is now ready to be worked on by the worker(s).

The second use of PWMA execution engine is to control workorders and help workers to progress through their job. Manager can control a state of the workorders in well-arranged workorder list or workorder answer list in the menu or in submenu for reports. They can also see work progress in workorder detail in the Flow diagram where it is shown the processed tasks and their state.

Manager can eventually modify the tasks, i.e., changing start/end, adding values to monitored attributes, reassign workers, or set task as completed if needed.

PWMA Execution engine also provides options for receiving notifications from workers, creating new workflows as clones from previous versions, and generate various reports.

3. INTEGRATION WITH BIMERR TOOLS

This chapter contains a detailed view on the integration strategies used by the different components.

3.1 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. BPMN model is passed to the PWMA backend automatically by API. It is also possible to do it manually. After the API receives the .bpmn file, it automatically calls for an ETL (Extract-Transform-Load) service, which transforms the BPMN model of the workflow to a model compatible with an internal PWMA data format. This process can also be done manually, if using a .bpmn file that was acquired outside of the API.

3.2 WORKER'S POSITION DATA SHARING

The PWMA backend contains an API for receiving the workers positions and storing them in the database. PWMA for on-site support uses them for enabling workers to only work on the workorders within their location. The positions are not being stored in the coordinates format showing the exact point within the building, instead they only tell which room the worker occupies. This information typically consists of a Space ID parameter unique for each room, as well the Space name. Positions in this format are ready to be shared with the other BIMERR components using a REST API webservice with a GET endpoint, if needed in the future.

3.3 INTEGRATION WITH APP FOR RESIDENTS AND APP FOR ON-SITE SUPPORT OF WORKERS

The application for on-site support of workers and the Workflow execution engine 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. 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.

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 to 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.

3.4 INTEGRATION WITH BIMERR IDENTITY PROVIDER

PWMA tools use BIMERR Identity provider to check the credentials of users trying to access the PWMA applications. We use different approaches depending on application tool being used.

3.4.1 Identity provider in the Execution Engine

Since the PWMA Execution Engine is web-based application (https://i3d.econtent.lu/bimerr/), we use a redirect pattern – we switch from our web to BIMERR identity provider web (Figure 42), where the user fills their credentials (https://auth.fit.fraunhofer.de/kc/realms/bimerr/protocol/openid-connect/auth), and after successful login, they are redirected to the PWMA web application.

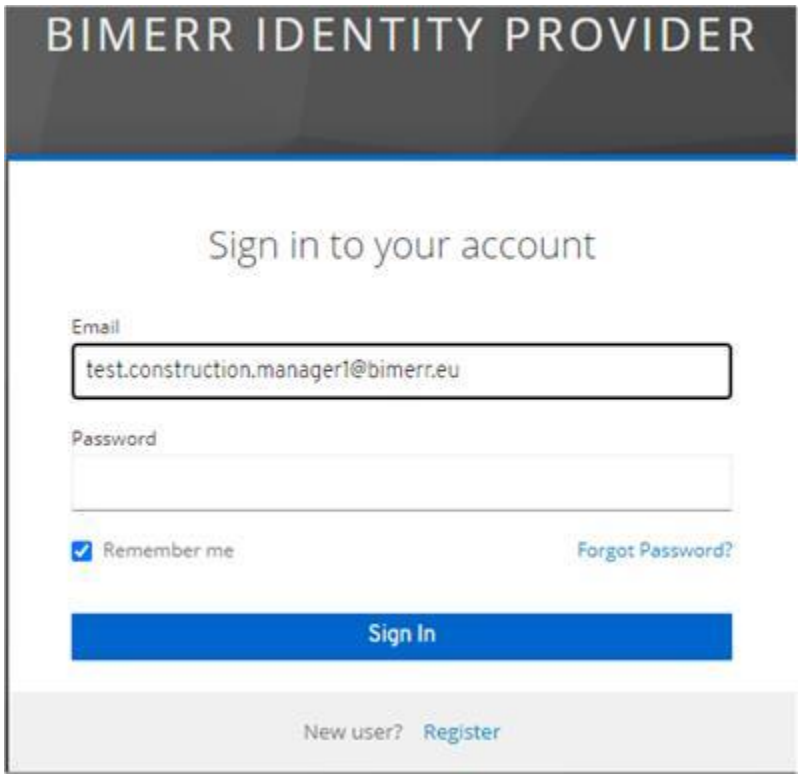

Figure 42 BIMERR identity provider

In the process of login/redirect we connect to BIMERR Keycloak API and exchange code from redirect for JWT token (Table 1). Then we validate the JWT token with a certificate received from https://auth.fit.fraunhofer.de/kc/realms/bimerr/protocol/openid-connect/certs. If valid, we process with that user, we parse their roles and assign them the appropriate permissions for our application. If the user is not in our system, we create the user in the PWMA database. This is processed automatically on every login to app.

Endpoint	
Method	POST
Format	application/x-www-form-urlencoded
Protocol	Https
Library	PHP/curl

Table 1 Identity provider webservice

3.4.2 Identity provider in the On-site support App

PWMA for on-site support app for workers is a Unity application running on a windows or android device and it is not possible to use the redirect pattern in it. Therefore, we implemented a login form and let users set their credentials which are exchanged directly for tokens.

3.4.3 Identity provider used elsewhere

One additional call for the Identity provider is occurring when we need to send our token to validate our application on an automated work, so we use application credentials for it.

PWMA backend also provides several endpoins for external systems, so we require valid BIMERR JWT tokens to be included in such requests. It involves endpoints for importing BPMN files from Modeling Tools and endpoints for workers positions getting/setting.

4. CATALOGUE OF TOOLS

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

4.1 WORKFLOW EXECUTION ENGINE (D6.7)

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

Users registered within the BIMERR identity provider are allowed to login to the PWMA tools for roles of Project Manager, Construction Manager and Construction Worker. New users are required to log in to the application to be registered on the PWMA toolset.

Users need to fill “client name= bimerr” to get to the application.

Notification web app is also available as SaaS on address https://notifications.econtent.lu/

4.2 SMART GLASS APPLICATION FOR ON-SITE RENOVATION WORKER SUPPORT (D6.9)

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

The user credentials for the application are the same as the web interface - same credential as another BIMERR tools. The “company name” needs to be set to “bimerr” (Figure 43).

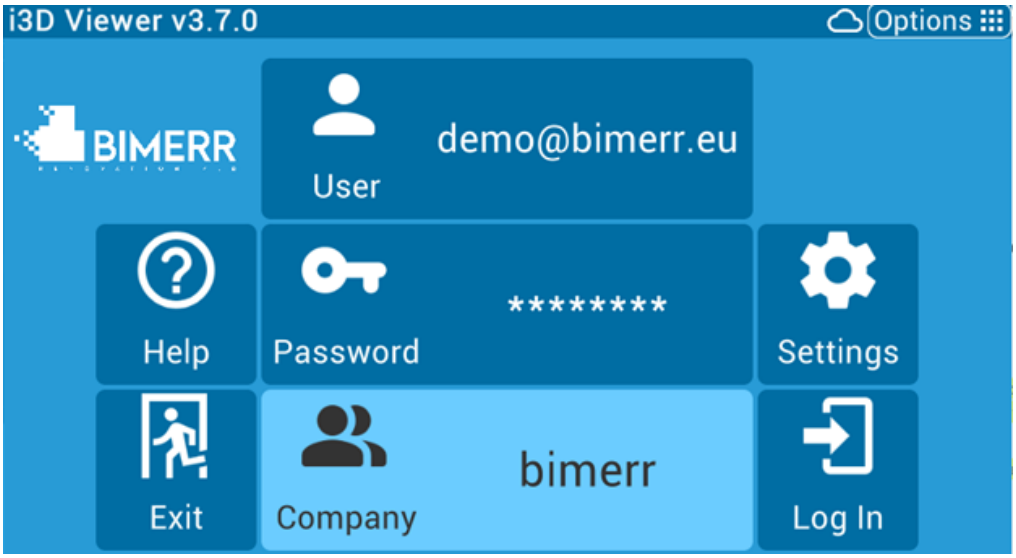

Figure 43 Logging to PWMA for on-site support

5. CONCLUSION

The technology that is described in this deliverable corresponds to the approach that is described in D6.3 “Adaptive Renovation Process & Workflow Models 2”.

This deliverable introduces the final version of the tool, which indicates, what are the key features of this component. In this version, most of the functionalities have been developed and are available for the user to be used manually.

In the future revisions and versions of the PWMA system, we are planning to integrate and implement a communication with BIMERR Interoperability Framework (BIF). This will allow other components to use the data created and stored in the PWMA, particularly the work orders and their results.

This document explains the workflow execution engine using following points:

- Description of the I3D system and terms used.
- Description of the main functionalities of the workflow execution engine, such as:
    - a) creation or import of the work process template,
    - b) creation of a digital twin of the work process,
    - c) monitoring and management of the digital twin,
    - d) digital twin process log,
    - e) push notification system.
- Communication toward PWMA for on-site support, modeling tools and others BIMERR tools
- Notification subsystem of PWMA execution engine

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BIMERR Consortium (2020). D6.3 – Adaptive Renovation Process & Workflow Models 2

BIMERR Consortium (2020). D6.5 - Renovation Process Simulation Tool 2

BIMERR Consortium (2020). D6.9 - Smart glass application for on-site renovation worker support 2