



Project Acronym: **BIMERR**
 Project Full Title: **BIM-based holistic tools for Energy-driven Renovation of existing Residences**
 Grant Agreement: **820621**
 Project Duration: **45 months**

DELIVERABLE D6.6

Adaptive workflow management & automation tool 1

Deliverable Status: **Final**
 File Name: **Deliverable D6.6**
 Due Date: **31/07/2020 (M19)**
 Submission Date: **31/07/2020 (M19)**
 Task Leader: **Novitech (T6.4)**

Dissemination level	
Public	X
Confidential, only for members of the Consortium (including the Commission Services)	



This project has received funding from the European Union's Horizon 2020 Research and innovation programme under Grant Agreement n°820621

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REVISION CONTROL

Version	Author	Date	Status
0.1	Novitech	05/06/2020	ToC
0.2	Novitech	10/06/2020	ToC - update
0.3	Novitech	22/06/2020	Draft for each section prepared
0.4	Novitech	30/06/2020	Extension of chapters.
0.5	Novitech	07/07/2020	Ready for 1 st Internal Review
0.6	Novitech	10/07/2020	Ready for 2 nd Internal Review
0.7	Novitech	13/07/2020	Ready for Review
0.8	Novitech	28/07/2020	Reviewers remarks reflected. Ready for 2 nd Review by BOC and CERTH
0.9	Novitech	30/07/2020	Header+Footer added
1.0	Novitech	31/07/2020	Ready for submission

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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 first version of the Adaptive workflow management & automation tool, which we consider as a main tool for project manager and involved stakeholders to manage and monitor the status of the whole reconstruction process.

The provided tool is 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:

- Importing the workflow created in the external modelling component
- Management of the workflows
- Creation of digital twins – real running instances of the processes
- Monitoring and management of the digital twins
- Exporting data and process log for other components

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 will be 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 D6.2 “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 provides the web based application, which is made available as SaaS at <https://i3d.econtent.lu/bimerr/>.

In parallel to the iteration of D6.2, which improves the way how renovation process management is performed in BIMERR, the follow up proposal of this document D6.7 will correspondingly adapt 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

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 provide 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 (D6.8) 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 wearing smart glasses, it contains all the basic functionalities needed to manage a reconstruction process. These functionalities are going to be 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 the D6.8 “Smart glass application for on-site renovation worker support 1” which uses the platform as back-end.

1.2 THE I3D METHODOLOGY AND TAXONOMY

The already existing I3D solution is used and adjusted accordingly the BIMERR needs to provide the functionality of executing the workflow. 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.

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.

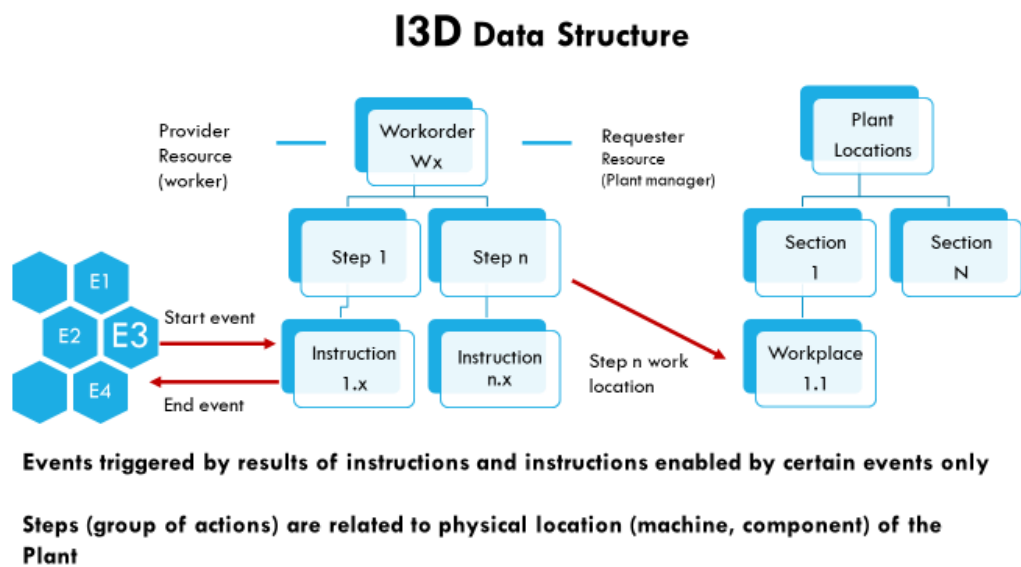


Figure 1 I3D Data structure

1.2.1 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.



Figure 2 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 3) can be used to generate a running instance – a digital twin of the work process.

Bimerr | bimerr

I3D Industrial Services

I3D-WF: Definition of workflow

v3



Workflow Management

Workflow

Step

Action

Resources

Assign Resources to Actions

Precondition

Location Management

Location

Hotspot Management

Hotspot

Assign Multimedia to Hotspots

Multimedia Management

Upload Files

Workflow approval ?

Commit approval

Back

Workflow name

Facade Improvements - Inside of the Wall

Valid from

Valid to

2020-07-09 22:46

2020-07-09 22:46

Approved by

bimerr_demo

Figure 3 Workflow approval procedure to protect work process template against unauthorized changes

1.2.2 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.

1.2.3 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.

1.2.4 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 4 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.

Expand
Collapse
Reload tree

- ▼ W1 Facade Improvements - Outside of the Wal
 - ▼ S1 Start
 - A1 Start
 - ▼ A2 Install Material Lift or Crane
 - E1 Install Material Lift or Crane
 - E119 Crane installed
 - ▼ A3 Install Safety Measure
 - E2 Install Safety Measure
 - ▼ A4 Building Scaffold
 - E3 Building Scaffold
 - ▼ A5 Is Gas or Electricity reorganised?
 - E4 Is Gas or Electricity reorganised?
 - ▼ A6 Reorganisation of Gas, Electricity, Tele
 - E5 Reorganisation of Gas, Electricity, Tele

Event ID

E119

Detail

Event name

Crane installed

Description

The crane has been installed and is ready to be used.

Figure 4 Example of event

1.2.5 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 5). 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.

Expand
Collapse
Reload tree

▼ W1 Facade Improvements - Outside of the Wal

▼ S1 Start

A1 Start
▼ A2 Install Material Lift or Crane

E1 Install Material Lift or Crane
E119 Crane installed

▼ A3 Install Safety Measure

E2 Install Safety Measure
E120 Safety Measures Ready

▼ A4 Building Scaffold

E3 Building Scaffold
P1 Crane&safety measures ready

▼ A5 Is Gas or Electricity reorganised?

E4 Is Gas or Electricity reorganised?

▼ A6 Reorganisation of Gas, Electricity, Tele

E5 Reorganisation of Gas, Electricity, Tele

Precondition ID

P1

Detail

Precondition name

Crane&safety measures ready

Description

S1A2- Crane installed AND S1A3- Safety Measures Ready

Remove precondition

Figure 5 Precondition of an action

Example of definition of preconditions is displayed on Figure 6. 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.

Precondition-item ?

Save
Clone
Delete
Back

Precondition name

Crane&safety measures ready

Precondition ID

1

Workflow

Facade Improvements - Outside of the Wal

Facade Improvement Template

Condition editor

AND

OR

+ Rule

+ Ruleset

E: Crane installed

action status



E: Safety Measures Ready

action status



Generate description

Precondition - verbal description

S1A2- Crane installed AND S1A3- Safety Measures Ready

Event - math representation

E119S1A2 && E120S1A3

Precondition - json

```
{
  "condition": "and",
  "rules": [
    {
      "id": "E119S1A2",
      "text": "Crane installed"
    },
    {
      "id": "E120S1A3",
      "text": "Safety Measures Ready"
    }
  ]
}
```

Figure 6 Mathematical and Human readable definition of a precondition

1.2.6 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.

1.2.7 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 7, 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.

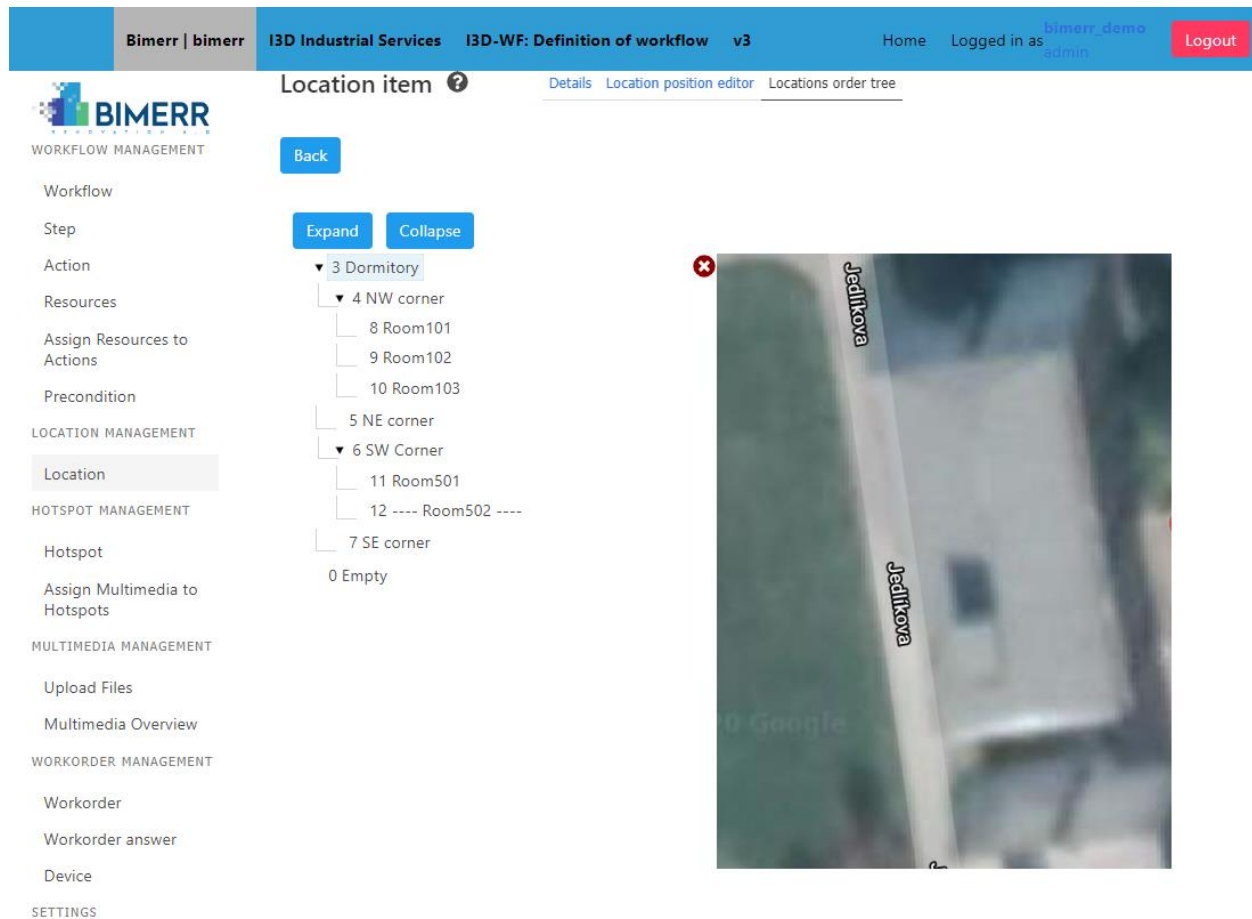


Figure 7 Location tree. Root node represented by a 2D picture - a map cut-out

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.

1.2.8 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.

1.2.9 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.

1.2.10 Providers

Providers are the users of the system. Every user can have assigned different user roles (Figure 8). Every user role provides a set of permissions for the user that determines the functionalities accessible for the user.

Provider ?

Save

Delete

Change password

Back

Provider name

bimerr_demo

Provider ID

2

Description

bimerr_demo

Login

bimerr_demo

New password

New password

☒ Activated

Provider roles

Role	Description	
super_admin	super administrator of the system	<input type="checkbox"/>
admin	administrator of the client installation	<input checked="" type="checkbox"/>
wf_editor	user defining workflows	<input type="checkbox"/>
wo_manager	user managing work orders	<input type="checkbox"/>
worker	smart glasses user executing work orders	<input checked="" type="checkbox"/>

Figure 8 User management inside the I3D

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** provides details of the Workflow execution engine. In this chapter, the key features of the component are described.
- **Chapter 3** provides details about the integration of the tool with the rest of the BIMERR toolset, in particular with the modelling and simulation tool, BIF, the monitoring tool and the applications for workers and residents.
- **Chapter 4** describes details about how to access and from where to download the described tools.
- **Chapter 5** contains the conclusions and the outlook remarks.

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 WORKFLOW MANAGEMENT

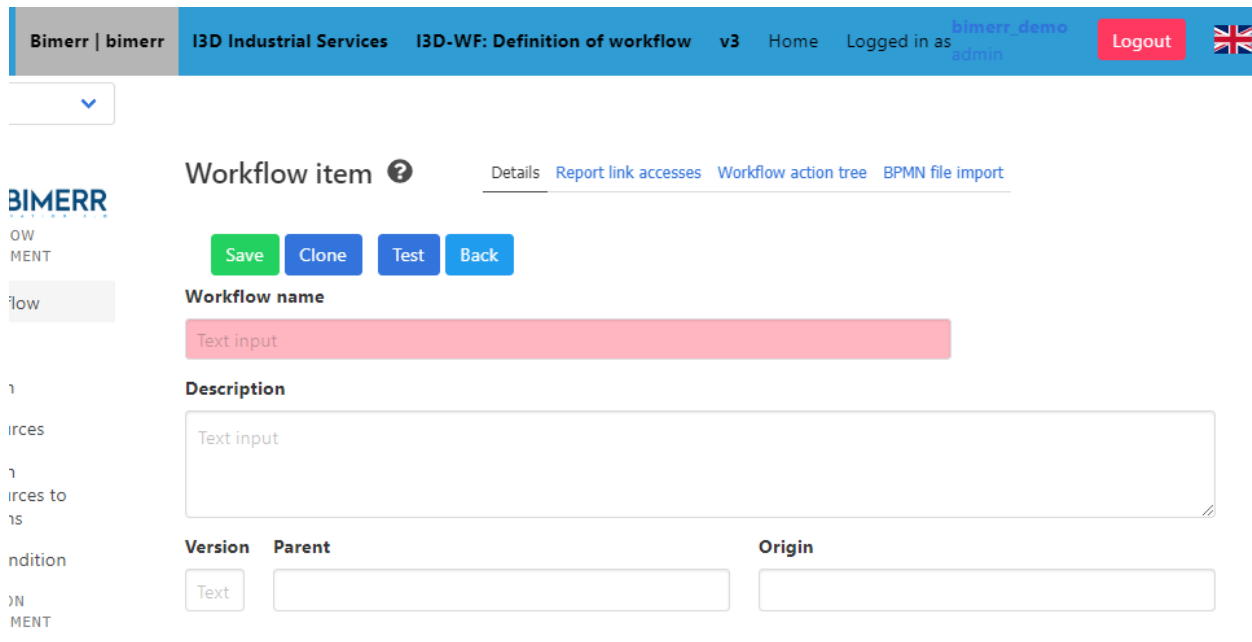
The workflow management part of the tool is used to create and manage the know-how of a plant or company. In context of BIMERR, it is a repository of work processes, which are connected to a building reconstruction process.

Although, we expect that most of the work process templates will be defined in third party modelling tools and will be imported to the I3D system, there is also the option to define a whole work process from scratch (Figure 9). 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 when 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 concrete 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 be also 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.

2.1.1 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 three example process templates, which have been produced in Deliverable D6.2 “Adaptive Renovation Process & Workflow Models 1”.



Workflow item ?

Details Report link accesses Workflow action tree BPMN file import

Save Clone Test Back

Workflow name

Text input

Description

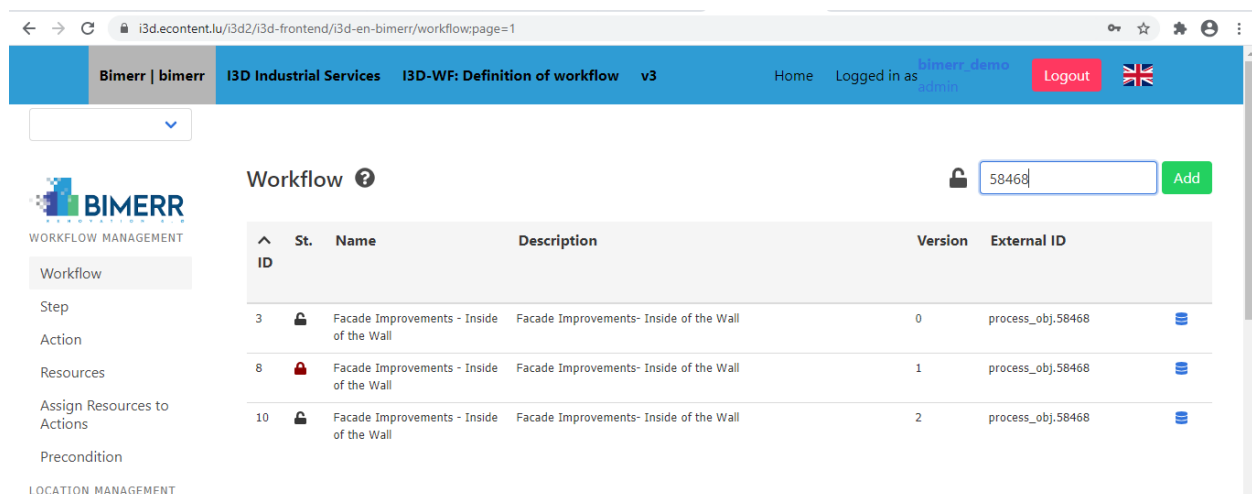
Text input

Version **Parent** **Origin**

Text

Figure 9 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 10). 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.



Workflow ?

58468 Add

ID	St.	Name	Description	Version	External ID
3	🔒	Facade Improvements - Inside of the Wall	Facade Improvements- Inside of the Wall	0	process_obj.58468
8	🔒	Facade Improvements - Inside of the Wall	Facade Improvements- Inside of the Wall	1	process_obj.58468
10	🔒	Facade Improvements - Inside of the Wall	Facade Improvements- Inside of the Wall	2	process_obj.58468

Figure 10 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, 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.

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 11). In case of missing attributes, the Project manager can define his own ones, as well (Figure 12).


Bimerr bimerr I3D Industrial Services I3D-WF: Definition of workflow v3			
		Home	Logged in as bimerr demo admin Logout 
Precondition	19	OBJECT_TYPE	hidden
LOCATION MANAGEMENT	20	DISPLAY_ACCOUNTABLE_FOR_APPROVING_RESULTS	hidden
Location	21	DISPLAY_TO_INFORM	hidden
HOTSPOT MANAGEMENT	22	REPRESENTATION_NAME_GATEWAY	hidden
Hotspot	23	A_CONVERGING	active
Assign Multimedia to Hotspots	24	TYPE_END	hidden
MULTIMEDIA MANAGEMENT	25	DISPLAY_NAME	hidden
Upload Files	26	Performer	active
Multimedia Overview	27	Waiting time	active
WORKORDER MANAGEMENT	28	Resting time	active
Workorder	29	Transport time	active
Workorder answer			
Device			
SETTINGS			

Figure 11 Management of attributes

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I3D-WF: Definition of workflow v3

Home

Logged in as [bimerr demo school](#)

Logout





WORKFLOW MANAGEMENT

Workflow

Step

Action

Resources

Assign Resources to Actions

Precondition


LOCATION MANAGEMENT

Location

HOTSPOT MANAGEMENT

Hotspot

Assign Multimedia to Hotspots

Business flow attribute 

Save

Back

Attribute name

Average number of participants

Attribute ID

34

Description

Average number of participants

External ID

Average number of participants

Active

☒

Figure 12 Task based attribute evidence

2.2 DIGITAL TWIN 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.

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I3D-WF: Definition of workflow v3

Home Log

Step

Action

Resources

Assign Resources to Actions

Precondition

LOCATION MANAGEMENT

Location

HOTSPOT MANAGEMENT

Hotspot

Assign Multimedia to Hotspots

MULTIMEDIA MANAGEMENT

Upload Files

Multimedia Overview

WORKORDER MANAGEMENT

Workorder

Workorder answer

Device

SETTINGS

Provider

Report links management

Attributes

Notification types

Workorder ?

Save

Back

Description

New Workorder

Planned start

2020-07-09 22:28

Actual start

Planned finish

2020-07-14 22:28

Actual finish

Workflow

Facade Improvements - Inside of the Wall

Facade Improvements- Inside of the Wall

Main provider

bimerr_worker

bimerr_worker

Main device

RW HMT-1

RealWear HMT1

Figure 13 Creation of a work order - digital twin

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 14). Before the process of creations is started, the planned starting date and planned finish date, as well as the responsible main provider needed to be set (Figure 13).

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WORKFLOW MANAGEMENT

Workflow

Step

Action

Resources

Assign Resources to Actions

Precondition

LOCATION MANAGEMENT

Location

HOTSPOT MANAGEMENT

Hotspot

Assign Multimedia to Hotspots

MULTIMEDIA MANAGEMENT

Upload Files

Multimedia Overview

WORKORDER MANAGEMENT

Workorder

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Flow diagram

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Workorder Result

Type to search

Step ID	Step ID	Step Name	Act ID	Act Name	Act Description	Provider Name	Provider Description	Result Text	Answer Type
1	1	Start	1	Start	obj.58004 Start for Start	bimerr_demo	bimerr_demo		YES
2	1	Start	2	Install Material Lift or ...	obj.58195 task for Install Material Lift or Crane	bimerr_demo	bimerr_demo		YES
3	1	Start	3	Install Safety Measure	obj.58018 task for Install Safety Measure	bimerr_demo	bimerr_demo		YES
4	1	Start	4	Building Scaffold	obj.58010 task for Building Scaffold	bimerr_demo	bimerr_demo		YES
5	1	Start	5	Is Gas or Electricity reo...	obj.58058 exclusive for Is Gas or Electricity reo...	bimerr_demo	bimerr_demo		Empty
6	1	Start	6	Reorganisation of Gas, El...	obj.58054 task for Reorganisation of Gas, Electri...	bimerr_demo	bimerr_demo		Empty
7	1	Start	7	Exclusive Gateway	_80218efb-b90c-4077-9ca7-bf6571ff28db exclusive f...	bimerr_demo	bimerr_demo		Empty
8	1	Start	8	De-installation and cover...	obj.58026 task for De-installation and covering o...	bimerr_demo	bimerr_demo		Empty
9	1	Start	9	Cleaning of the surface o...	obj.58029 task for Cleaning of the surface of fac...	bimerr_demo	bimerr_demo		Empty
10	1	Start	10	Even the existing facade	obj.58032 task for Even the existing facade	bimerr_demo	bimerr_demo		Empty
11	1	Start	11	Which Facade Type?	obj.58082 exclusive for Which Facade Type?	bimerr_demo	bimerr_demo		Empty
12	1	Start	12	Create SATF	obj.58076 task for	bimerr_demo	bimerr_demo		Empty

Figure 14 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.

2.3 DIGITAL TWIN MONITORING AND MANAGEMENT

The I3D provides different User Interfaces (UI) via which the work order can be managed. The most important are the (a) web-based interface, which is supposed to be used by the project manager, and (b) the application, 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 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 15). 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.

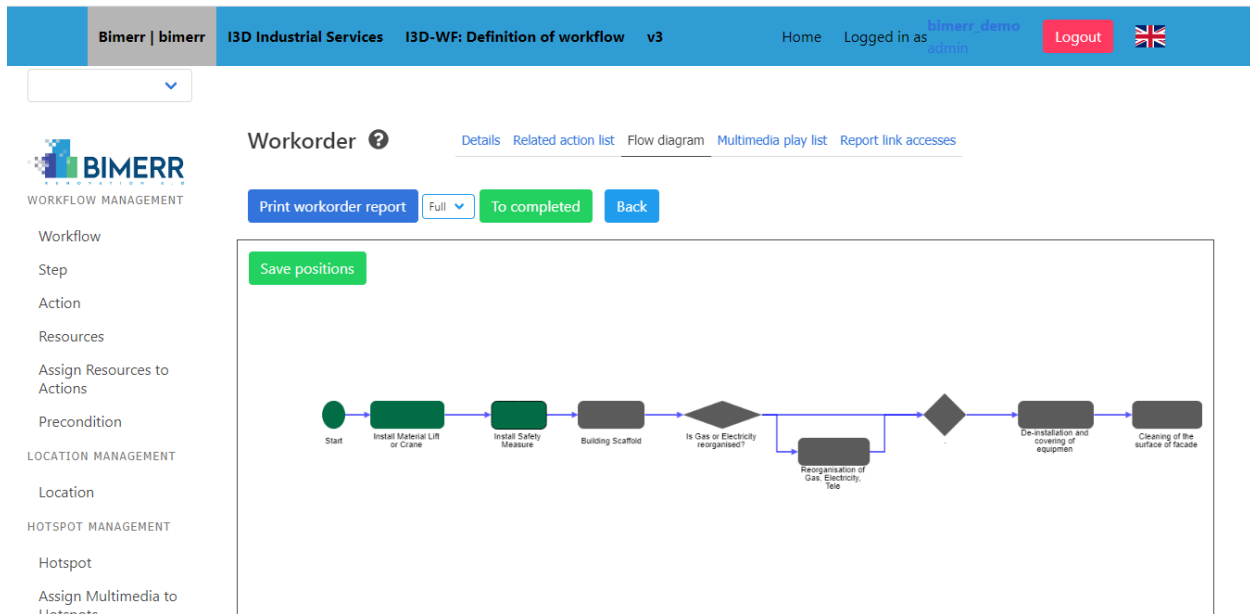



Figure 15 Visualization of the running work order

The project manager is allowed to re-plan the work order in terms of changing the planned starting and ending date and time for every ongoing tasks and to set the real starting and real ending for each task, including the status of every task (Figure 16). For the not started work orders, the main provider can be replaced, and the task marked as completed can be re-opened or re-issued by the project manager in case of need.

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Location Management

- Location

Hotspot Management

- Hotspot
- Assign Multimedia to Hotspots

Multimedia Management

- Upload Files
- Multimedia Overview

Workorder Management

- Workorder**
- Workorder answer
- Device

Settings

- Provider
- Report links management
- Attributes
- Notification types

[Save positions](#)

[Start](#) [Create Manual LA or Create](#) [Create from Resource](#) [Building Scaffold](#) [Is this a temporary reorganization?](#) [New Position](#)

Workorder result detail

[Details](#) [Attributes](#) [Sub workorders](#) [Affected locations](#) [Back](#)

Action name
Building Scaffold

WorkorderResult ID
4

Action ID
4

Action result text
Text input

Planned start
2020-06-10 08:00

Real start
2020-06-10 09:00

Planned end
2020-06-17 17:00


Real end
2020-06-22 16:09

Action result status
Empty

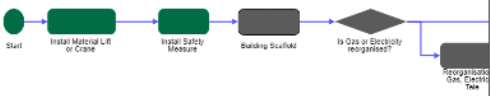
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Figure 16 Rescheduling the task

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 order of the running work order (Figure 17). 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.




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Connected sub workorders

Workorder Number	Workorder Name	Start	Status	
Facade Improvement	Test:Facade Improvement	2020-07-02 13:44:00	Created	
BIM-002-002	Test:BIM-002-002 test	2020-06-28 22:11:21	Paused	
Quality check	Test:Quality check of scaffold	2020-06-18 22:09:00	Paused	

Workorder

Provider

Planned start **Actual finish**


Status

[Edit subworkorder](#) [Clear](#) [Back](#)


Figure 17 Assignment of sub-work orders to a task of the main work order

Other important way of interaction with the work order is the attributes management (Figure 18). 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.

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Values of attributes

Name	Type	Value
COSTS	Planned	0
COSTS	Real	500
COSTS	Real	200
COSTS	Real	500
EXECUTION_TIME	Planned	0

Attribute

A_RESTING_TIME

Value type

Real


Value

Comments

Figure 18 Attribute management on task level

One of the key requirement 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. The project manager can define his own H&S issue categories. The web based UI allows to set for every task, which locations are going to be affected by the execution of the particular task as well as to mark, what type of H&S issue could occur on the affected locations (Figure 19).

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Start

Install Material Lift or Crane

Install Safety Measure

Building Scaffold

Is One or Electricity reorganised?

Reorganise One Electric Pole

Affected locations

Id	Location	Text	Notes	N
6	SW Corner	South West corner - all floors	Noise	Y
4	NW corner		Vibration	N

Location

NW corner

North-West corner of the building

Text

Note

Vibration

Vibrations can occur due to drilling

Notification needed

No

Update

Clear

Figure 19 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 to all the work orders assigned to him (Figure 20). Once the work order execution has been started, the application provides step-by-step, action-by-action guidance for the worker through the work order. The beginning of the execution of every action is confirmed by the user (Figure 21). 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 22). 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 23). The application for on-site support of the workers is described in more detail in the Deliverable D6.8 “Smart glass application for on-site renovation worker support 1”.

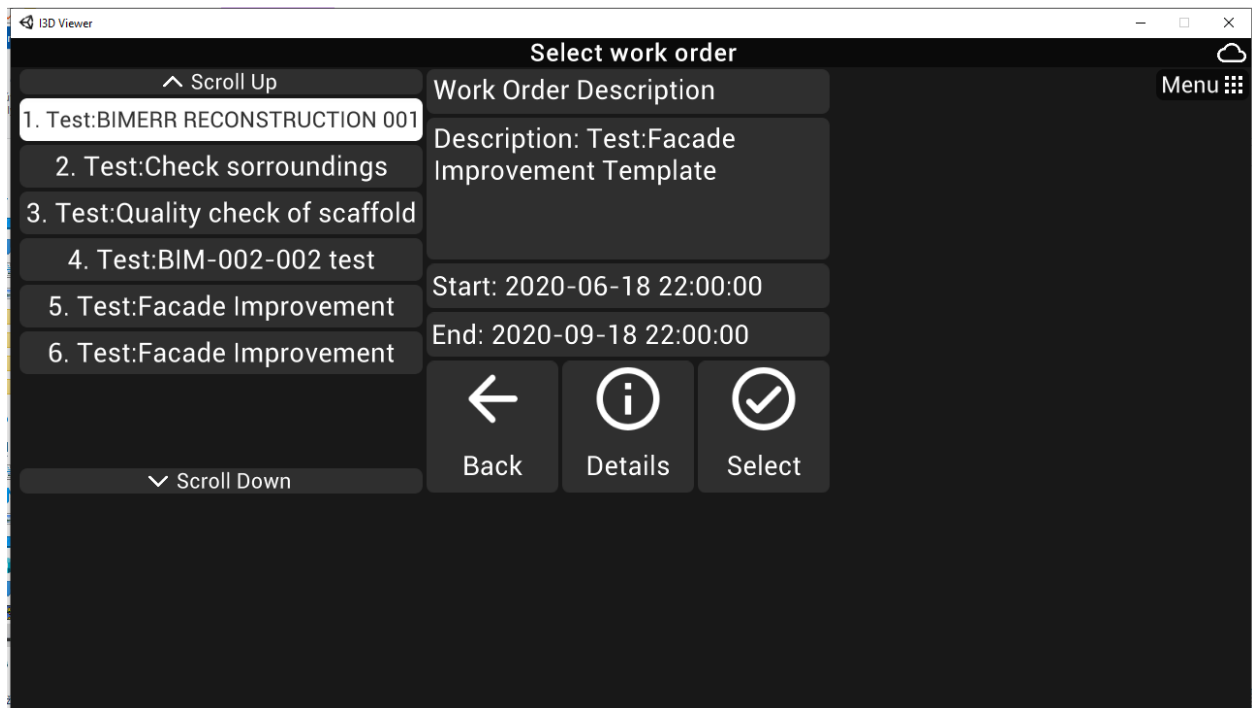


Figure 20 List of work orders assigned to the user displayed in the application for mobile devices

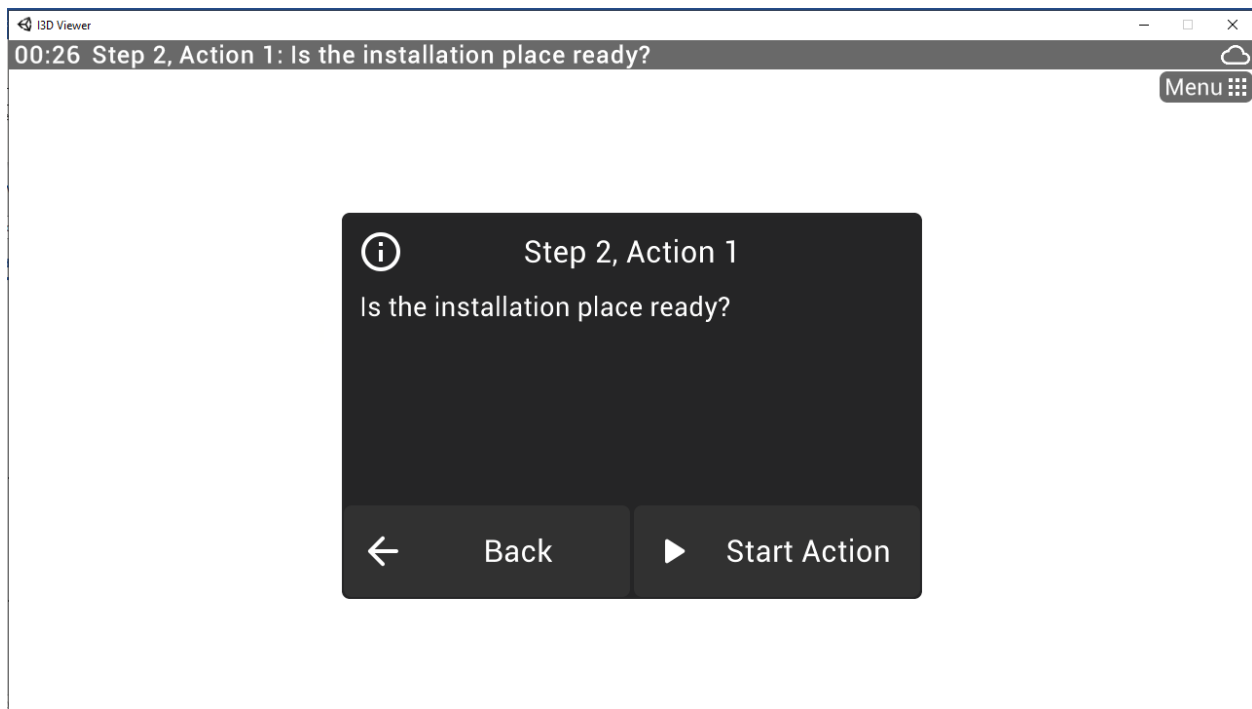


Figure 21 Starting the execution of a task in the app for mobile devices

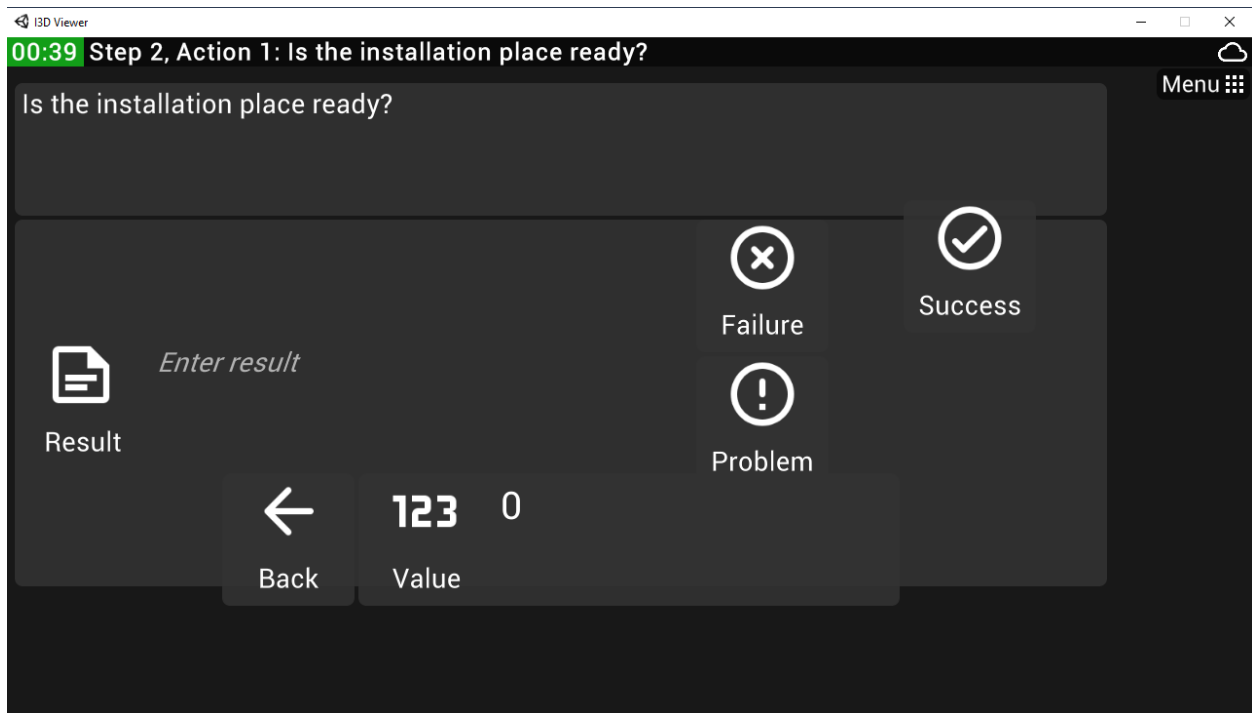


Figure 22 Confirmation of the successful execution of a task via the app for mobile devices

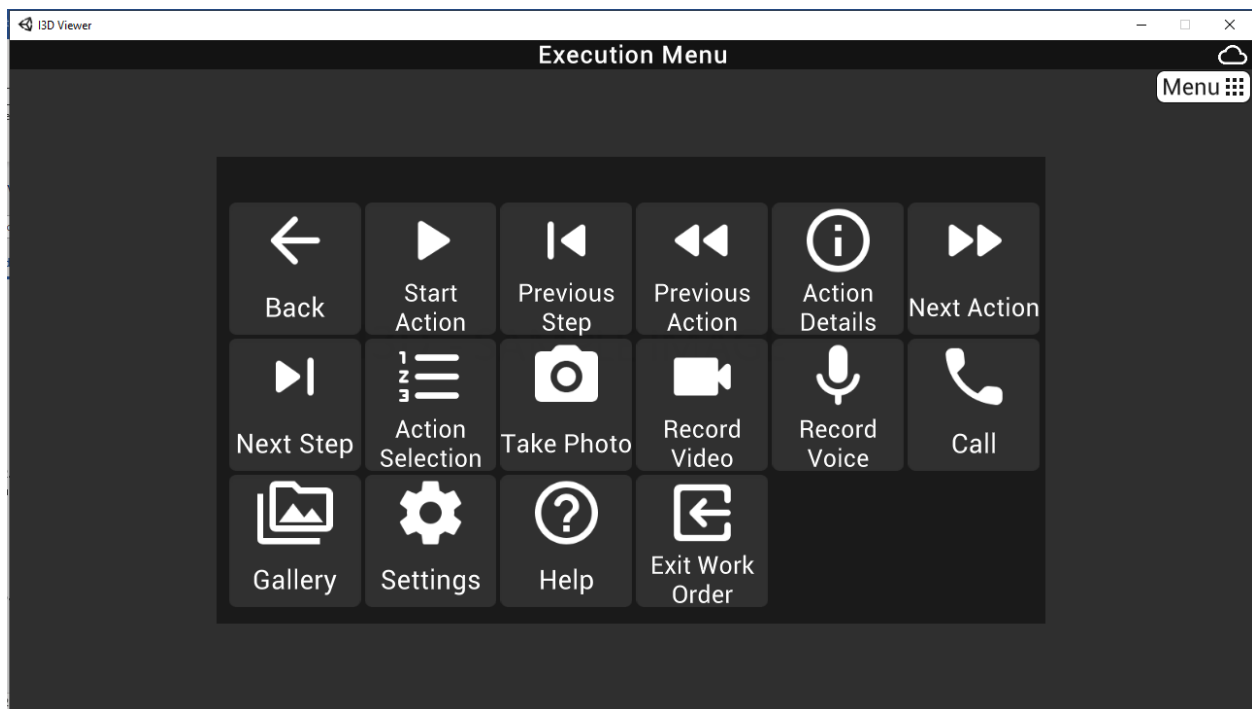


Figure 23 Tool set available for the worker in the app for mobile devices

2.4 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 24). The second REST API endpoint provides detail data about a digital twin with all the data related to the selected work order (Figure 25). This process log is in form of structured JSON, which makes it easy for other component to process and extract the data needed.

```

← → ↻ i3d.econtent.lu/i3d2/i3d-logvalues-backend/public/workflow?externId=process_obj.58134
4  [
5  {
6    "workflow": {
7      "header": {
8        "id": 1,
9        "name": "Facade Improvements - Outside of the Wal",
10       "building_id": 379930,
11       "project_id": "process_obj.58134"
12     },
13     "workorders": [
14       {
15         "header": {
16           "id": 1,
17           "name": "Test:BIMERR RECONSTRUCTION 001",
18           "description": "Test:Facade Improvement Template",
19           "start": {
20             "planned_start": "2020-06-18 22:00:00",
21             "actual_start": null
22           },
23           "finish": {
24             "planned_finish": "2020-09-18 22:00:00",
25             "actual_finish": null
26           }
27         },
28         "tasks": [
29           {
30             "id": 1,
31             "name": "Start",
32             "description": "obj.58004| Start for Start",
33             "execution_time": {
34               "planned": {
35                 "id": 51,

```

Figure 24 REST API Output - JSON with a list of work orders created from a selected work process template

```

4  {
5    "workorder": {
6      "header": {
7        "id": 1,
8        "name": "Test:BIMERR RECONSTRUCTION 001",
9        "description": "Test:Facade Improvement Template",
10       "start": {
11         "planned_start": "2020-06-18 22:00:00",
12         "actual_start": null
13       },
14       "finish": {
15         "planned_finish": "2020-09-18 22:00:00",
16         "actual_finish": null
17       }
18     },
19     "workflow": {
20       "header": {
21         "id": 1,
22         "name": "Facade Improvements - Outside of the Wal",
23         "building_id": 379930,
24         "project_id": "process_obj.58134"
25       }
26     },
27     "tasks": [
28       {
29         "id": 1,
30         "name": "Start",
31         "description": "obj.58004| Start for Start",
32         "execution_time": {
33           "planned": {
34             "id": 51,
35             "workorder_result_id": 1,
36             "logattributes_id": 1,
37             "value": 5,
38             "comments": null,
39             "start": "2020-06-01 08:00:00",
40             "end": "2020-06-01 08:10:00"
41           },

```

Figure 25 REST API Output - JSON with process log of the selected work order

2.5 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. Integrated in the second version of the Workflow execution engine will be a push notification system, which will allow, for every user, to subscribe to different notification groups. This will provide a tool to better inform the stakeholders about H&S issues, limitations, and rescheduling of the works. The notification system will be used also to inform the workers about new assigned tasks, reschedule or terminate of the already assigned tasks and other relevant changes on which the workers could have interest.

3. 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.

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. 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.

3.2 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 and 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.

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 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. 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 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.

3.4 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 provide 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.

4. CATALOGUE OF TOOLS

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

4.1 WORKFLOW EXECUTION ENGINE

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

A new user need to register via “Ask for registration” (Figure 26). 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.

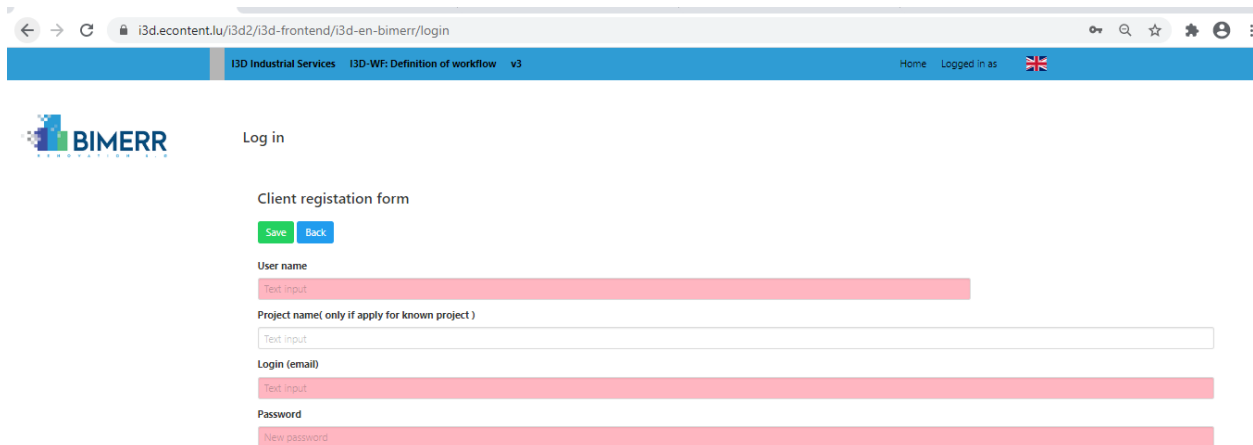


Figure 26 Registration form to become a user of I3D

4.2 SMART GLASS APPLICATION FOR ON-SITE RENOVATION WORKER SUPPORT (D6.8)

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 27).

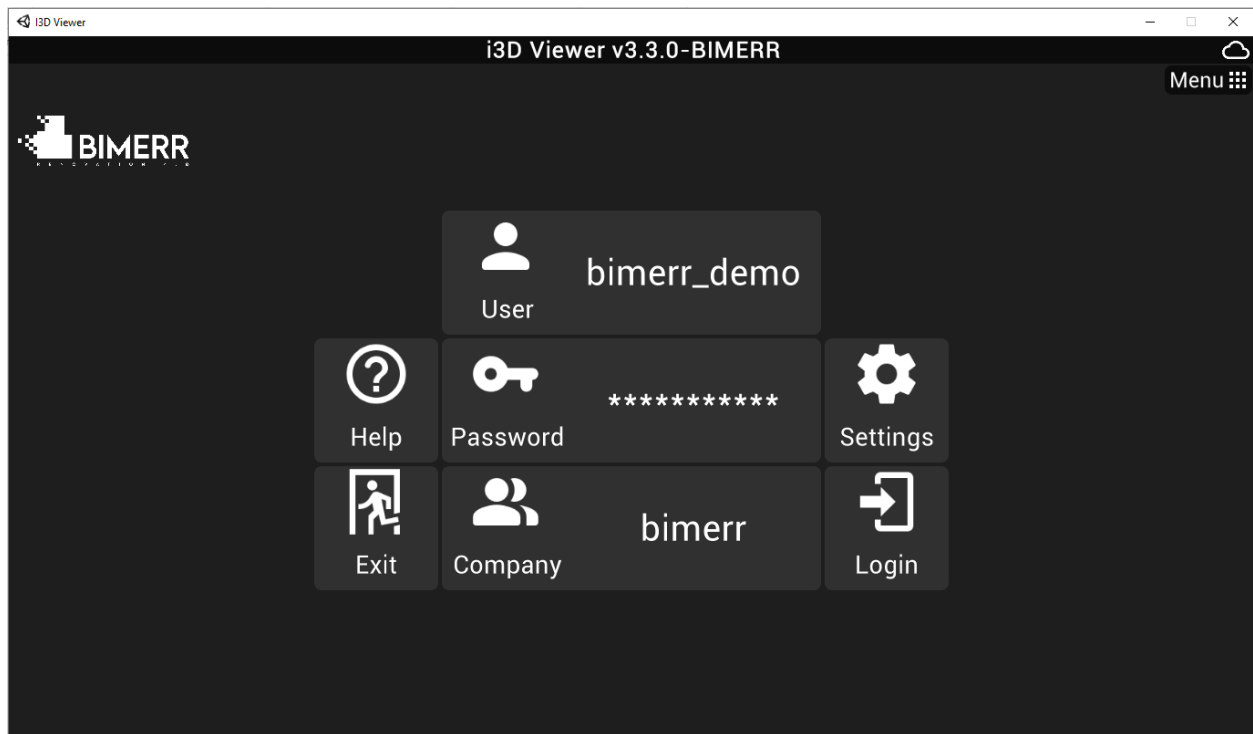


Figure 27 App log-in

5. CONCLUSION 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.

This deliverable introduces the first 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.

This document explains the workflow execution engine by:

- First, describe the I3D system and terms used.
- Second, describe the main functionalities of the workflow execution engine, such as a) creation or importing the work process template, b) creation of digital twin of the work process, c) monitoring and management of the digital twin, d) digital twin process log and e) push notification system.

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

- Improving UX design and automatization of the functionalities via API calls to external systems.
- 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 modeling tool will be able to inform the Project Manager about updates on the work process model he is using. The project manager will be able to provide info for the process modeler about finishing some tasks of the reconstruction process. The residents will receive instant notification about unforeseen issues or issues reported by their neighbors.
- Integration with the BIF will be implemented to achieve tighter combination with legacy systems.

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