INSITER INTUITIVE SELF-INSPECTION TECHNIQUES

Training modules and pilot training courses

Deliverable report D6.1

Deliverable Report: 6.1, issue date on Nov 30th, 2018 (Revised version)

INSITER - Intuitive Self-Inspection Techniques using Augmented Reality for construction, refurbishment and maintenance of energy-efficient buildings made of prefabricated components.

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Colophon

This research project has received funding from the European union's H2020 Framework Programme for research and innovation under Grant agreement no 636063.

Publishable executive summary

This deliverable is part of work package 6 ***'Training, communication, dissemination and exploitation'***. It is documenting developed training materials and their application within INSITER. Training materials for awareness creation and training materials supporting the usage and implementation of INSITER tools have been developed. Furthermore, a summary from the work done on integration of self-instruction within the BIM-model and the use of Augmented reality is given. This deliverable concludes with progress in the development of an INSITER learning community of practice that supports development and dissemination after project duration.

INSITER developed a new methodology for self-inspection during construction, refurbishment, maintenance and commissioning, along with a dedicated toolset. The INSITER Methodology, consist of protocols and guidelines for self-inspection and self-instruction that enable workers of general contractors and subcontractors, site supervisors, technical experts, quality auditors, clients and building occupants to use the methodology with the supporting INSITER Systems (hardware and software). The INSITER dissemination strategy relies on a 'hands-on approach' to stimulate a steep learning curve, by focusing on creating awareness and learning-on-the-job. Training modules and accompanying materials are developed in direct relation with the developed tools, real case studies, field demonstration and pilot projects.

The following knowledge transfer means have been developed.

1. Trainings and workshops dedicated to awareness development in the involved value chain.
   With the aim to actively involve all project sub-contractors and their on-going projects and partners.
2. Trainings and workshops dedicated to self-inspection and use of advanced portable systems
   With the aim to train & support users of the developed INSITER tools and to implement the INSITER tools within the building process.
3. Integration of on-site self-instruction content-objects within the BIM-model
   With the aim to deliver self-instruction Just-in-Time (within the building process) and Just-in-Place (to the right person(s) and the right BIM-objects or BIM-elements involved)
4. Use of Augmented Reality (AR) for on-site self-instruction purposes
   Augmented Reality (AR) is applied with the aim to deliver object specific related content within the AR-environment.
5. Development of a community of practice around INSITER
   To enable train the trainer schemes and addition of self-inspection to the qualification schemes we use the in BUILD UP Skills projects developed methodology for composing so called didactic matrices.
   The within INSITER developed training content on self-inspection and the use of INSITER is disseminated using the Learning Management System (LMS) of aNewSpring and the BUILD UP Skills advisor app. INSITER has used the available BUILD UP community for dissemination purposes.

List of acronyms and abbreviations

- AR: Augmented Reality
- BIM: Building Information Modelling
- DoA: Description of the Action
- HVAC: Heating, Ventilation, Air Conditioning
- nZEB: Nearly Zero Energy Building
- LLL: Life Long Learning
- LMS : Learning Management System
- QA: Quality Assurance
- QC: Quality Control

Definitions

Augmented Reality

Is a technology that superimposes the computer-generated virtual content over a live view of the world which not only contains the input from the 3D model but may also have sound, video, graphics or GPS data inputs enhancing our perception of real-world situations. It has the potential to change how site managers and construction workers can interact and access to virtual information in real-time.

- ***Building Information Model***

Is a method for optimizing the design, execution and operation of building structures. The basis of BIM is formed by a 3D computer model which can be enhanced by adding further information, such as time, costs, utilization. It is not a software package but a method of working, collaborating, designing, managing, constructing and operating.

- ***BIM-based simulation of processes***

Refers to simulations that uses BIM-based 3D models and associated work plans to visualise process sequences and construction or assembly steps among other issues like maintenance or inspection processes. In the context of INSITER the focus is on BIM-based simulation of processes for self-instructions purposes.

- ***Self-inspection***

Encourages, enables and equips construction workers to check their own working processes and the results respectively, both individually as well as peer-to-peer with other workers.

- ***Self-instruction***

Is a pro-active approach to provide craftsmen and professionals with interactive guidance during their working processes. Self-instruction is facilitated on the workers' mobile devices, with continuous updates based on both pre-planned (designed) process as well as real-time feedback from self-inspection. Self-instruction prevents wrong actions and helps the workers to rectify any error immediately.

- ***Learning Management System***

A learning management system (LMS) is a software application for the administration, documentation, tracking, reporting and delivery of educational courses or training programs. Within INSITER the aNewSpring LMS is used (www.anewspring.com).

Fulfilment of the Description of Action (DoA) in D6.1

Fulfilment of WP, Task and Deliverable scope and objectives

Summarised objectives as stated in DoA	Results presented in this deliverable
WP 6 scope and objectives: • Objective of WP6 is to ground results from the INSITER research project in real practice in the construction sector by way of: - internalisation (enabling the targeted users of INSITER results and incorporating the INSITER solutions within the organisation and project workflows, and embedding INSITER solutions in guidelines, norms and standards); as well as - externalisation (creating the common ground / acceptance in practice, promoting INSITER solutions to a wider audience, and paving the way towards implementation and exploitation in the market)	Addressed directly in this deliverable: • Development and pilot implementation of training modules focussing on awareness creation and on the self-inspection and self-instruction approaches developed in INSITER • Development of an INSITER community of practice both for internalisation as well as externalisation ▪ Addressed in collaboration with other deliverables: • Integration of self-instruction within the BIM-model is addressed in D4.2 and D4.4 • The use of augmented reality is addressed in D2.1 • Embedding INSITER solutions in norms and standards is addressed in D6.2 ▪

Summarised objectives as stated in DoA	Results presented in this deliverable
Task 6.1 'Training and standardisation' scope and objectives:	Addressed:
• Gathering practical knowledge and building up experience with self-inspection and coupled with on-site instructions.	• By desk research and networking activities, for example results of experiments in the Netherlands with inspection protocols and documented lessons learned
• Implementing self-instructions to mobile devices of construction workers; providing supervision and support when needed.	• In WP2 and by collecting experiences from projects with similar approaches
• Organising pilot training courses for the targeted users of INSITER results. Including the testing the self-instruction modules in practice.	• In the pilots in Enschede and Seville elements of the developed training have been tested.
• Testing how self-instruction content can be activated when a learning issue is found during self-inspection.	• Addressed in cooperation with the WP2-team, by introducing clash detection cubes
• BIM for self-instruction for the building occupants: the as-built virtual building model showing the operation manuals of the building –interactively accessible through the construction actors' mobile devices	• Addressed in WP2
• Integrating lessons-learned in the self-inspection protocols.	• Based on the experience gathered in INSITER a method to document building errors suitable for learning is designed.
• Impact evaluation of the training modules that makes it possible to show the added value of INSITER training.	• In the pilot in Seville elements of the developed training materials have been evaluated.
• Use of Virtual Reality (VR) training facilities when necessary.	• Within INSITER there was no need to use VR training facilities
• Adding self-inspection methods to enrich the existing qualification schemes of construction actors.	• Self-inspection methods and lessons learned in INSITER are added to existing qualification schemes.
• Preparing and introducing skill-oriented professional training and certification programmes to workers / professional associations in all countries where INSITER consortium partners are present.	• Unit of Learning Outcomes have been defined for skill-oriented professional training and certification programmes. There is exchange with several H2020 projects on this topic.
• Establishment of a community of practice in conjunction with the European training network in the on-going EU BUILD UP Skills programme; thus, disseminating INSITER results in the EU.	• Connections are made with H2020-project PROF/TRAC, BIMplement, BUStoB and several other projects. The BUILD UP network has been used for dissemination of pilot results.

Summarised objectives as stated in DoA	Results presented in this deliverable
Deliverable D6.1 scope and objectives: • Gathering practical knowledge and building up experience with self-inspection, coupled with on-site instructions • Establishment of a community of practice in conjunction with the European training network • Pilot training(s) for involved stakeholders and construction workers • Publication of practical guidelines • Skill-oriented professional training and certification programmes ▪	Addressed: • With desk research and networking activities ▪ • In collaboration with PROF/TRAC, BUStoB and BUILDUP.eu • In September 2018 a pilot training was given to involved employees at DRAGADOS in Seville. In WP1 the guidelines have been developed. In WP6 based on the output of WP1 a guide for developing new guidelines will be published. • In WP6 Unit of Learning outcomes have been defined for working with the INSITER approach and toolset. These are exchanged with several other EU H2020 projects. ▪

Table of contents

1. Introduction

This deliverable is part of work package (WP) 6 ***'Training, communication, dissemination and exploitation'***.
The objective of this work package is to ground the innovative results from the INSITER research project in real practice within the construction sector by internalisation and externalisation activities:

- **Internalisation:** Enabling the targeted users of INSITER results and incorporating the INSITER solutions within the organisation and project workflows, and embedding INSITER solutions in guidelines, norms and standards.
- **Externalisation:** Creating the common ground / acceptance in practice, promoting INSITER solutions to a wider audience, and paving the way towards implementation and exploitation in the market.

This deliverable is documenting the rationale behind and realisation of the INSITER Training modules and pilot training courses. It also includes an evaluation of the usability of these training modules.

The overall goal of INSITER and the role of self-inspection and self-instruction

INSITER develops a new methodology for self-inspection during construction, refurbishment, maintenance and commissioning, along with a dedicated toolset. The INSITER Methodology, consist of protocols and guidelines for self-inspection and self-instruction that enable workers of general contractors and subcontractors, site supervisors, technical experts, quality auditors, clients and building occupants to use the methodology with the supporting INSITER Systems (hardware and software).

Applied innovation is the use of "self-inspection" and "self-instruction" for construction workers:

- **Self-inspection:** encourages, enables and equips the construction workers to check their own working processes and the results respectively, both individually as well as peer-to-peer with other workers.
- **Self-instruction:** is a pro-active approach to provide the workers with interactive guidance during their working processes. Self-instruction in INSITER is facilitated on the workers' mobile devices, with continuous updates based on both pre-planned (designed) process as well as real-time feedback from self-inspection. Self-instruction prevents wrong actions and helps the workers to rectify any error immediately.

1.1 Training products to be delivered

The training rationale of INSITER has been based on a "growth model". This model shares the built-up experience during the INSITER project in four levels:

- Level A: training on self-inspection with known tools;
- Level B: training dedicated to self-inspection and use of advanced portable systems;
  Including the Unit of Learning Outcomes defined for skill-oriented professional training and certification programmes.
- Level C: Integration of on-site self- instruction and self-inspection content-objects within the BIM-model;
- Level D: Use of Augmented Reality (AR) for on-site self-instruction purposes.

The following knowledge transfer products have been developed on the four levels.

1. **Level A:** Training on self-inspection with known tools - an e-learning dedicated to awareness development on quality assurance and existing tools usable for this purpose.
2. **Level B:** training dedicated to self-inspection and use of advanced portable systems - with the aim to train and support users of the developed INSITER tools and to implement the INSITER tools within the building process and the application of INSITER in the involved value chain. With the aim to actively involve all project sub-contractors and their other on-going projects and partners.
    a. A stakeholder workshop introducing the INSITER 8-step methodology.
    b. A modular training and syllabus for and supporting implementation of the INSITER 8-step methodology and related INSITER tools.
    c. A short syllabus on the use of the advanced and portable ultrasound system combined with ultra-graphics (in Dutch and English).

    To support further implementation of INSITER results also several qualification profiles with INSITER related competences have been developed. These qualifications are addressing needed tasks, subtasks, knowledge, skills and competences.
    a. A Qualification on BIM based Quality Assurance using the INSITER 8-step method.
    b. A Qualification on application of the improved thermographic measurement.
    c. A Qualification on application of the SoundBrush array.
3. **Level C:** Integration of on-site self-instruction content-objects within the BIM-model Addressed in WP3 and 4.
    With the aim to deliver self-instruction *Just-in-Time* (within the building process) and *Just-in-Place* (to the right person(s) and the right BIM-objects involved):
    a. A tutorial for using the Step-By-Step instruction generator
    b. The BIM clash-cubes
    c. Guidelines app
4. **Level D:** Use of Augmented Reality (AR) for on-site self-instruction purposes Addressed in WP4
    Training modules are blended with learning with support of Augmented Reality (AR).

1.2 Related tasks in other work packages

The work of work package 6 is closely related to several other INSITER tasks in work packages 1 to 5.
In WP6 the results of the other work packages has been analysed and restructured to a flexible set of training materials, including input for qualifications.

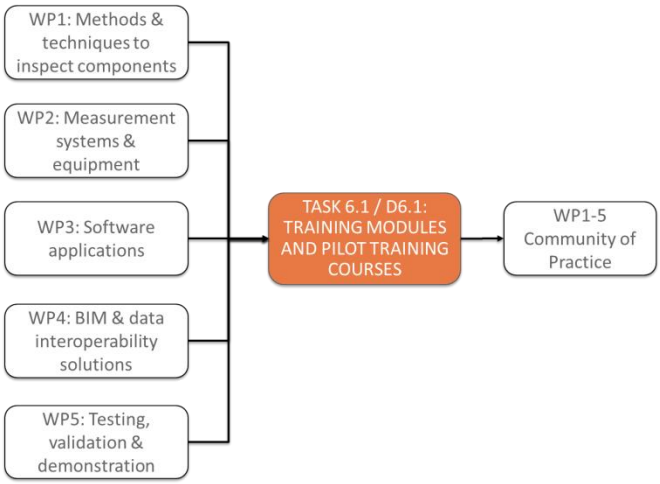

Figure 1: Input & output from and to deliverable D6.1

WP1 Task 1.1

In this task process methodologies are being developed with the focus on prefab-based new and retrofitted buildings. Guidelines for self-inspection and self-instruction will enable workers of general contractors and subcontractors, site supervisors, technical experts, quality auditors, clients and building occupants to use the methodology with the supporting INSITER Systems (hardware and software). This includes guidelines for implementing INSITER Systems (hardware and software), supported by digital communication, authorisation and decision-making between all stakeholders. Furthermore, self-inspection in the quality assurance systems and standardisation is embedded (protocols - checklists).

Input for:

- ✓ **Level B:** training dedicated to self-inspection and use of advanced portable systems.

WP1 Task 1.2

In task 1.2: Self-inspection techniques and quantifying methods for construction components including process methods for self-inspection are elaborated and embedded in the conventional and integrated collaborative processes in construction. Also, self-instruction information, related to measurements, is extracted as guidelines for the construction workers.

Input for:

- ✓ **Level B:** training dedicated to self-inspection and use of advanced portable systems.

WP1 Task 1.3: Self-inspection techniques and quantifying methods for MEP/HVAC components including process methods for self-inspection are elaborated and embedded in the conventional and integrated collaborative processes in construction. Also, self-instruction information as guidelines for the construction workers is extracted. Furthermore, self-inspection in the quality assurance systems and standardisation is embedded (protocols - checklists).

Input for:

- ✓ **Level B:** training dedicated to self-inspection and use of advanced portable systems.

WP2

- The measurement method for thermographic measurement
- Knowledge, Skills and competences needed have been documented in a Qualification for application of the method.
- The SoundBrush measurement with a microphone array
  Knowledge, Skills and competences needed will be documented in November 2018 in a Qualification for application of the microphone array (from Siemens).
- The ultrasound and ultragraphics measurement method.
  Knowledge, Skills and competences needed have been documented in a Qualification for application of the microphone array. A short training syllabus (in Dutch) has been developed and published as e-learning. This training syllabus will be translated before the end of the project
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WP3

Guidance on the application of the integrated software toolset with applications for quality, performance and process optimization within projects

- The INSITER collaboration platform and its linked applications;
- End-user guidance application RE Guidelines app;
- The RE Maintenance software and RE OnSite app.
  -

Input for:

- ✓ **Level B:** training dedicated to self-inspection and use of advanced portable systems.

WP4 Task 4.2

In task 4.2: Data interoperability and BIM-based self-instruction; self-instruction models based on BIM are developed, in conjunction with the development of training modules in WP6/T6.1.

- Embedding BIM in Augmented Reality (AR), and extracting BIM process information into 'self-instructions' (e.g. installation manuals and planning schedule) for construction workers on their mobile devices (e.g. iPad).
- D4.4: BIM-based self-instruction models for mobile devices.
-

Input for:

- ✓ **Level C:** Integration of on-site self-instruction content-objects within the BIM-model
- ✓ **Level D:** Use of Augmented Reality (AR) for on-site self-instruction purposes

WP5

To involve the different groups of stakeholders in testing, validation and demonstration in conjunction with training, dissemination and exploitation activities in WP6. Within work package 5, related tasks are:

- Task 5.2: Validation in new construction and refurbishment;
  Field validations will be carried out based on real case studies of new and existing buildings
- Task 5.3: Demonstration in new construction & refurbishment;
  The demonstration activities will show evidence of the final performance of the buildings, and the scale of improvements made by using the prototype INSITER Systems and Methodology. Field demonstration will serve as guideline to organise the demonstration activities and as a template to document the outcomes.
  The output will be one of the main key points for dissemination and exploitation activities in order to enhance the adoption of the INSITER approach in construction self-inspection activities across Europe.
-

Input for:

- ✓ **Level B:** training dedicated to self-inspection and use of advanced portable systems;
- ✓ **Level C:** Integration of on-site self-instruction content-objects within the BIM-model;
- ✓ **Level D:** Use of Augmented Reality (AR) for on-site self-instruction purposes.

1.3 Reading guide

This deliverable follows the sequence described in the growth model:

- Chapter 2 Training on self-inspection with known tools
- Chapter 3 Training dedicated to self-inspection and use of advanced portable systems
- Chapter 4 Integration of on-site self-instruction content-objects within the BIM-model
- Chapter 5 Use of Augmented Reality (AR) for on-site self-instruction purposes
- Chapter 6 Development of an INSITER learning community

2. Training on self-inspection with known tools

A training and workshop dedicated to awareness development on quality assurance and the application of INSITER in the involved value chain has been developed. This training addresses the goals of self-inspection and the tools involved. It also gives an overview of the in INSITER operationalised 8-step method. This with the aim to actively involve all project sub-contractors and their other on-going projects and partners. This fits in the 'growth' model of INSITER with Level A: training on self-inspection with known tools.

The training material has been developed with the following purposes in mind:

1. General awareness on the value of self-inspection and a variety of self-inspection methods available.
2. Awareness about the influence of building errors on the (energy and quality) performance of buildings.
3. General awareness about the value of INSITER as a quality improvement method and tool.

2.1 Development of the 'awareness' training

To enable train the trainer schemes and addition of self-inspection content to the qualification schemes (in chapter 6) we used the in BUILD UP Skills BUStoB project developed methodology for composing a so called didactic matrix. In this matrix based on eleven questions the blueprint for the developed training was composed.

Determination of target groups and composed didactic matrix

Topics addressed	Knowledge elements (knowing, understanding)	Management	Contractor / project	Subcontractor
What is self-inspection?	Self-inspection is a method applied by workers with easy to use tools to see if the regulations, dictates and/or requirements are being met. Some inspections cannot be performed by workers, they are additionally applied by quality inspectors.	X	X	X
What is the importance of self-inspection in sustainable building?	The added value of self-inspection is, generally, to give insight in what happens on the construction site. The realised quality is documented and defects can be fixed in a timely manner. Quality issues can be prevented in the future if followed up properly. With regulations getting stricter, because of sustainable building, the inspection afterwards no longer suffices. The inspection results can be used during the in-use phase when specific questions about performance or retrofits have to be answered.	X	X	X

How does self-inspection work?	The inspections take place during and after the construction process. During these moments the realised work is checked and documented. Work is done following self-inspection protocols and by using self-inspection software and tools.	X	X	X
Minimum basic knowledge and understanding of self-inspection.	Self-inspection protocols, self-inspection software & apps, measuring instruments (blowerdoor, smoke generators, thermometers, thermographic camera's, SoundBrush, ultrasound, flowmeters, etc.)	X	X	X
Required knowledge and expertise for self-inspection with INSITER tools.	Integration of self-inspection results in BIM-models, thermographic INSITER measurements, etc.	X	X	X
What you need to pay attention to when working with INSITER tools (Process driven).	The links between the guidelines app, RE onsite app, the checklist and the BIM-model. The input gathered is used for quality improvement and process documentation.	X	X	
Which actions concerning self-inspection with INSITER tools are relevant?	To take photos of the finished job and of the crucial installation points during and after installation.		X	X
What types of self-inspection are available?	Checklists, photo material, thermographic inspections, SoundBrush inspections, detail comparisons, etc.		X	X
What types of devices or platforms support the use of INSITER tools?	Smartphones, laptops, tablets, AR-glasses.	X	X	X
What are the innovations for self-inspection.	Self-inspection no longer confines itself to visual inspections but moves to detailed and structured documentation inside BIM-models and the cloud. The 8-step INSITER methodology.	X	X	
Which laws and regulations are important for self-inspection.	Country specific laws and regulation	X	X	

Based on the didactical matrix first the Dutch version of the training materials has been developed. Development was done in the aNewSpring Learning Management System. After a feedback round within the Dutch members of the INSITER consortium the training content is translated into English. The aNewSpring LMS facilitates these two versions as two separate learning journeys.

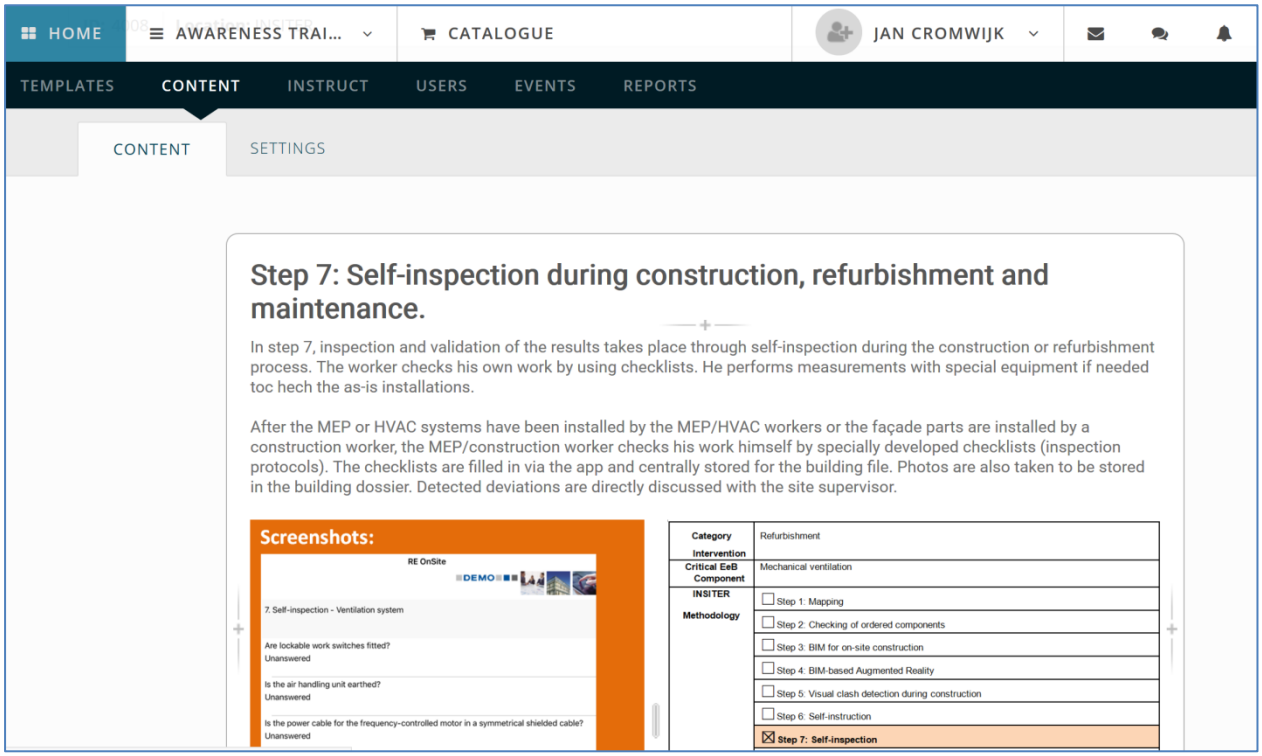


Figure 2: Screenshot of the training in the used LMS aNewSpring

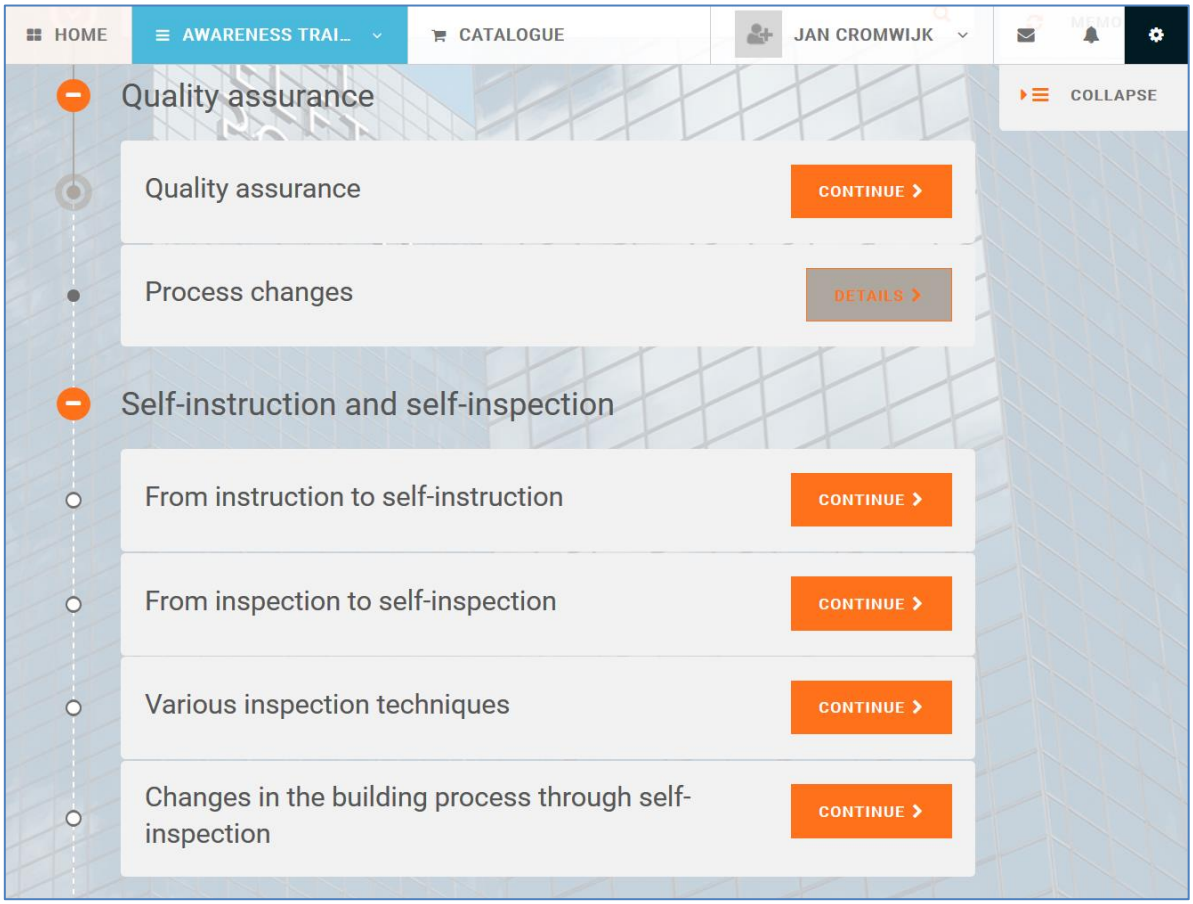


Figure 3: Overview of the Awareness training

2.2 Piloting of the 'awareness' training

Based on the developed materials several pilots using those materials have been organised.

1. A pilot with the online e-learning module
2. A stakeholder workshop in Enschede
3. A stakeholder workshop in Seville

2.2.1 Pilot with the online e-learning module

After processing the results of testing within the consortium the revised 'awareness' module has been published.

We have invited several groups of stakeholders for joining the piloting of this module.

1. On social media by publishing an invitation on LinkedIn and Twitter
2. Personal invitations of stakeholders within the INSITER network

The testing period of the online e-learning module was too short to yield enough results for improvement of the module.

2.2.2 Stakeholder workshop in Enschede

As part of the M42 meeting a stakeholder workshop with the focus on contractors, project managers and investors has been organised. Some of the materials from the 'awareness' training has been used during this workshop. This in combinations with on-site demonstration of developed functionality. In addition, the Value proposition canvas method was used to evaluate the value of the demonstrated INSITER functionality & to gather input for the exploitation and business plan.

Results:

- a workshop usable for demonstration purposes
- a set of value propositions developed in co-creation with stakeholders

The training materials consist of a PowerPoint and a set of free downloads from www.strategyzer.com.

Needed working materials:

- the-value-proposition-canvas-instruction-manual
- the-value-proposition-canvas
- the-value-map
- the-customer-profile

Extra working materials:

- customer-jobs-trigger-questions & a-day-in-the-life-worksheet
- customer-pains-trigger-questions
- customer-gains-trigger-questions
- pain-relievers-trigger-questions
- gain-creators-trigger-questions
- ad-lib-value-proposition-template

2.2.3 Stakeholder workshop in Seville

On the 28th of September 2018 a stakeholder workshop was organised in Seville. During this workshop materials from the 'awareness training has been used in combination with demonstrations of the developed INSITER functionality.

Four persons working at DRAGADOS followed this session. All indicate the usefulness of INSITER methodology. Most of them are especially interested in the applied testing methods. Value of INSITER is "Usefulness and ratio between easy-to-use and time to spend in the inspection vs obtained results".

Result: a short training suited for short training sessions on INSITER and introduction of the methodology.

3. Training self-inspection, advanced portable systems

This chapter describes the development of training programs with the aim to train and support users of the developed INSITER tools and to implement the INSITER tools within the building process. Most of the developed training materials are targeted at the middle management (white collars) responsible for off- and onsite implementation.

The training materials involve:

- Several PowerPoints:
  I. One for a short introduction workshop (also suitable for blue collar workers)
  II. One for the implementation training in several possible training programs or variants
- A syllabus for the implementation training with more detailed explanations and background information
- A syllabus for the Ultra-graphics module (also suitable for blue collar workers);
- A set of linked manuals and trainings, targeting the use of involved software;
- An e-learning module on www.anewspring.com for awareness on Quality Assurance and an introduction of INSITER.

3.1 Setup of the implementation training

Based on the experience build up within INSITER development, the pilots and development of the 'awareness' training a modular structure for INSITER implementation trainings has been developed.

The training materials within the implementation training have been categorised in the following categories.

1. Introduction to INSITER and the 8-steps method
2. Fundamental knowledge needed for implementation
   a. The collaboration platform
      i. Linked trainings and instructions concerning tools involved
   b. The BIM-model & data needed for successful implementation
      i. Linked trainings and instructions concerning tools involved
   c. Guidelines available for implementation
      i. Linked instruction materials
      ii. Linked inspection materials
      iii. Formats for manufacturers and suppliers
3. Step-by-step Guidance on the implementation process
   a. Explanation of the step
   b. Off-site (preparation)
   c. On-site (execution)
   d. Actors involved in the step
   e. Actual application of the step, illustrated with examples
   f. Qualifications related to the step
4. Explanation on simulation based self-inspection of HVAC/MEP systems

Based on the specific target group and training goals selections out of these materials have to be made. As an example,

we have worked out several training scenarios. Each scenario is worked out in a definition of the target group, the training goals and a training program.

3.1.1 General introduction to INSITER and the 8-steps method

Training program	Introduction to INSITER and the 8-steps method
▪ Target group	▪ Persons interested in INSITER and the 8-steps method
▪ Goals	▪ To understand the importance and scope of INSITER ▪ To get a general view on the 8-steps method
▪ Length	▪ 30 to 60 minutes
▪ Prior INSITER knowledge needed	▪ None
▪ **Composition**	▪
▪ The importance of INSITER	▪ Selection of slides: 4 - 14
▪ The scope of INSITER	▪ Selection of slides: 15 - 18
▪ The 8 steps method	▪ Selection of slides: ▪ General explanation:19 – 20 ▪ Step 1: 44, 45, 50, 51 ▪ Step 2: 55 - 57 ▪ Step 3: 67, 70, 79, 80, 81 ▪ Step 4: 84 - 88 ▪ Step 5: 101, 105 ▪ Step 6: 110 - 115, 117 ▪ Step 7: 122, 123, 128, 129 ▪ Step 8: 149 – 152 ▪ Annex 5 - INSITER implementation training Syllabus V3.docx –Chapter 7 and 8
▪ The INSITER tools	▪ Selection of slides: 21, 22, 28-37
▪ **Important:** this training module is also integrated in the INSITER awareness e-learning.	

3.1.2 A commercial training to sell INSITER-solutions

Training program	A commercial training to sell INSITER-solutions
▪ Target group	▪ Persons interested in INSITER solutions for quality assurance
▪ Goals	▪ To get an overview of the developed INSITER Toolset ▪ To get an impression of the required implementation process ▪ To get an impression of the added value using the INSITER Toolset
▪ Length	▪ 60 - 90 minutes
▪ Prior INSITER knowledge needed	▪ None
▪ **Composition**	▪
▪ The importance of INSITER	▪ Selection of slides: 4 - 14
▪ The scope of INSITER	▪ Selection of slides: 15 - 18
▪ The 8 steps method	▪ Selection of slides: ▪ General explanation:19 – 20 ▪ Step 1: 44, 45, 50, 51 ▪ Step 2: 55 - 57 ▪ Step 3: 67, 70, 79, 80, 81 ▪ Step 4: 84 - 88 ▪ Step 5: 101, 105 ▪ Step 6: 110 - 115, 117 ▪ Step 7: 122, 123, 128, 129 ▪ Step 8: 149 - 152 ▪ Annex 5 -INSITER implementation training Syllabus V3.docx –Chapter 7 and 8
▪ The INSITER tools	▪ Selection of slides: 21, 22, 28-37
▪ INSITER implementation	▪ Selection of slides: 40 – 43, 157, 158
▪ **Extra activity** ▪ (30 minutes – 1 hour)	▪ Draft an INSITER value proposition together with the potential client. ▪ This can be done using the presentation of the Enschede workshop. ▪ See for more information 2.2 Piloting of the ‘awareness’ training
▪ **Important:** for this training module also, the PowerPoint presentation Annex 7 - INSITER & quality assurance version 4.pptx can be used. In this PowerPoint a minimal set of slides is pre-selected	

3.1.3 Preparing implementation of the 8-steps method for BIM-based quality assurance

Training program	Preparing implementation of the 8-steps method for BIM-based QA
▪ Target group	▪ White collars in building teams
▪ Goals	▪ To understand the connections between the 8-steps and the INSITER toolset ▪ To know which processes have to be arranged when applying the 8-steps method ▪ To understand the value of the measurement and AR-tools in the INSITER toolset
▪ Length	▪ Half a day
▪ Prior INSITER knowledge needed	▪ The INSITER awareness e-leaning OR the general introduction training module
▪ **Composition**	▪
▪ The 8-steps step by step: - Preparation-process - Tools involved - Skills needed ▪ - Results on-site ▪ (1 – 1.5 hour)	▪ Selection of slides and materials: ▪ Print Annex 9 - INSITER Process Chart V3.5.pptx on A3 or bigger ▪ 22-31 ▪ Print on A4 or bigger Annex 8 - INSITER Qualification on BIM enabled Quality Assurance.xlsx ▪ Step 1: 52, 53 ▪ Step 2: 57, 63, 64 ▪ Step 3: 71-75, 79, 81 ▪ Step 4: 88, 91-94 ▪ Step 5: 103 - 105 ▪ Step 6: 111-114, 117 ▪ Step 7: 125, 128 ▪ Step 8: 151
▪ Exercise: INSITER readiness ▪ (1 – 1.5 hour)	▪ In this exercise the trainees will use the INSITER process-chart to map and the INSITER qualification to assess the INSITER readiness of their own organisation ▪ This exercise can be done individual or in small groups with attendees from the same company. ▪ To make the training more dynamic the step by step explanation can be mixed with the exercise (after each step 5-10 minutes)
▪ Wrap-up ▪ 30 minutes	▪ A wrap-up of the results of the exercise. For example, in the form of result presentations or a step by step summary by the trainer/facilitator ▪

3.1.4 A full scale INSITER implementation training

Training program	A full scale INSITER implementation training
▪ Target group	▪ White collars responsible for INSITER implementation within a company ▪ BIM specialists involved in the INSITER implementation
▪ Goals	▪ Able to implement the processes needed for applying the 8-steps method ▪ Able to make a proper selection of INSITER and measurement tools needed ▪ Able to implement the processes needed for applying selected tools ▪ Able to prepare the data needed for applying selected tools ▪ Able to work with the guidelines app and collaboration platform
▪ Length	▪ One day when INSITER readiness is high ▪ Two days when INSITER readiness is low
▪ Prior INSITER knowledge needed	▪ Introduction to INSITER and the 8-steps method ▪ Preparing implementation of the 8-steps method for BIM-based QA
▪ **Composition**	▪ The 8-steps step by step:
▪ Step 1 – 8 ▪ Each step consists of walking through actions needed for implementation ▪ Preparation-process ▪ Preparation-data (BIM) ▪ Selecting tools ▪ Preparing tools ▪ Implementing tools ▪ Evaluate ▪	▪ Selection of slides and materials: ▪ Print Annex 9 - INSITER Process Chart V3.5.pptx on A3 or bigger ▪ Print on A4 or bigger Annex 8 - INSITER Qualification on BIM enabled Quality Assurance.xlsx ▪ Annex 5 -INSITER implementation training Syllabus V3.docx – Chapter 3 ▪ The full presentation Annex 4 - INSITER implementation training V3.pptx The trainer makes a selection of the slides based on the company profile and INSITER readiness. ▪ ▪ To harvest the training results an INSITER process chart can be printed on A0 so that with sticky notes the relevant company specific implementation actions can be added.

3.1.5 Adding products to the INSITER platform for manufacturers and suppliers

Training program	Adding products to the INSITER platform for manufacturers and suppliers
▪ Target group	▪ White collars at manufacturers and suppliers
▪ Goals	▪ To be able to add new products to the INSITER collaboration platform (Products can also be components or a set composed of several components) - An overview of all places where product related customisation is possible within the INSITER collaboration platform - Identification of the product with QR - Possibilities for adding the product to BIM-models for easy referencing - Adding product related mounting and maintenance instructions to the collaboration platform - Adding product related BIM-step by step IFC models for instruction - Adding self-inspection protocols - Optional: adding product specific thresholds - Optional: creating guidelines for new components
▪ Length	▪ Half a day (3 effective training hours)
▪ Prior INSITER knowledge needed	▪ The commercial training to sell INSITER-solutions or the INSITER awareness training
▪ **Composition**	▪
▪ An overview of the customisation process (30 minutes)	▪ Selection of slides: 26, 27, 28 Based on the architecture of the collaboration platform the trainer indicates customisation opportunities
▪ Exercise: Adding product identification (15 minutes)	▪ Selection of slides: 58 ▪ In this exercise the trainees will add a new product to the collaboration platform
▪ An overview of possibilities to add product BIM-details and AR (15 minutes)	▪ Selection of slides: 86, 91-94 ▪
▪ Exercise: Adding product related instructions (15 minutes)	▪ In this exercise the trainees will add product related mounting and maintenance model to the INSITER collaboration platform
▪ Adding product related BIM-step by step IFC models (15 minutes)	▪ Selection of slides: 31 ▪ D4.4 'BIM-based Self-Instruction models for mobile devices' as background documentation
▪ Exercise: Adding product related inspection protocols (45 minutes)	▪ Selection of slides: 33, 59, 148 ▪ In this exercise a product specific inspection protocol is created and added to the collaboration platform
▪ Adding product related thresholds (30 minutes)	▪ Selection of slides: 156, 131-145 for installation specific thresholds ▪ Annex 5 -INSITER implementation training Syllabus V3.docx - chapter 5

Training program	Adding products to the INSITER platform for manufacturers and suppliers
▪ Wrap-up ▪ 15 minutes	▪ A wrap-up and closure of the training by the trainer ▪

3.1.6 Adding new guidelines in the INSITER platform for manufacturers and suppliers

Training program	Adding products to the INSITER platform for manufacturers and suppliers
▪ Target group	▪ White collars at manufacturers and suppliers
▪ Goals	▪ To be able to add new products to the INSITER collaboration platform (Products can also be components or a set composed of several components) - Creating guidelines for new components - Creating product related inspection protocols - Optional: adding product specific thresholds
▪ Length	▪ Half a day (3-6 effective training hours)
▪ Prior INSITER knowledge needed	▪ The commercial training to sell INSITER-solutions or the INSITER awareness training
▪ **Composition**	▪
▪ Introduction to guidelines and adding new guidelines	▪ Introduction to guidelines, slides: 32-38
▪ Step by step explanation of the steps and after each step an exercise to write a first draft of the guideline for that step.	▪ Annex 5 -INSITER implementation training Syllabus V3.docx - chapter 4 ▪ Step 1: 54 ▪ Step 2: 66 ▪ Step 3: 83 ▪ Step 4: 100 ▪ Step 5: 109 ▪ Step 6: 121 ▪ Step 7: 147, 148 ▪ Step 8: 156
▪ Exercise: Adding product related inspection protocols (45 minutes)	▪ Selection of slides: 33, 59, 148 ▪ In this exercise a product specific inspection protocol is created and added to the collaboration platform
▪ Adding product related thresholds (30 minutes)	▪ Selection of slides: 156, 131-145 for installation specific thresholds ▪ Annex 5 -INSITER implementation training Syllabus V3.docx - chapter 5
▪ Wrap-up ▪ 15 minutes	▪ A wrap-up and closure of the training by the trainer ▪

3.1.7 A toolbox meeting for the on-site team

Training program	Introduction to INSITER and the 8-steps method
▪ Target group	▪ Blue and white collars working mostly on-site
▪ Goals	▪ To understand the importance of quality assurance ▪ Get the picture of the 8-steps method, impact onsite and expected results ▪ Able to use selected tools from the INSITER toolset
▪ Length	▪ 30 – 60 minutes
▪ **Composition**	▪
▪ The importance of QA (5 min)	▪ Selection of slides: 4 - 7 ▪
▪ The overall picture (10 min)	▪ Selection of slides: 7-15
▪ The Guidelines-app (5-15 min)	▪ Selection of slides: 20 ▪ Practical demonstration
▪ Re-onsite (5-15 min)	▪ Selection of slides: 39 ▪ Practical demonstration
▪ Application of AR (5-20 min)	▪ Selection of slides:88, 92-94 ▪ Practical demonstration

3.2 The training content follows the 8-step methodology

Self-inspection in INSITER will ensure the successful implementation of Energy Efficient Building (EeB) innovations by solving real problems during construction, refurbishment, and commissioning. Self-inspection will not disrupt on-site working processes by additional effort; it will save time and cost by making the processes efficient and accurate. The 8-step methodology supported by the relevant measurement and diagnostic instruments will close the gap between design and realisation in new construction, refurbishment and maintenance projects. This methodology is visualised in the following figure. Thereafter for each step a proposal is stated concerning training of users and the use of self-instruction content. The target group always exists of professionals and workers that are normally involved in the phases in the building process.

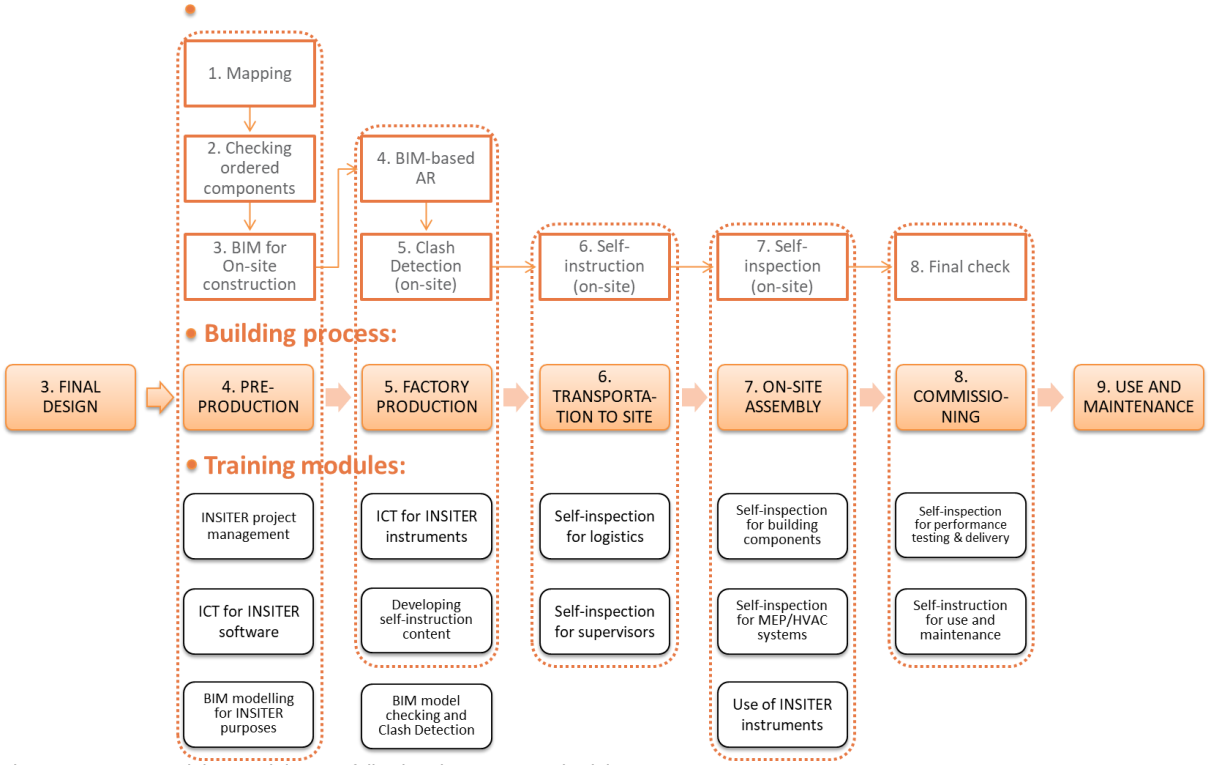


Figure 4 INSITER training modules are following the 8-step methodology

3.2.1 Step 1: Mapping the site and building

Mapping actual technical conditions of the site and building, and performing economic valuation of the property and land; capture the requirements and compare them to as-is situation.

This step is performed by the construction workers after receiving his work assignment. The workers check whether the working areas (e.g. construction site designated for a new building or a storey in the existing building) are cleared and ready for the planned construction/refurbishment activities. In case of refurbishment of existing HVAC/MEP systems, “mapping” also means assessing the condition of the existing systems.

Health and safety regulations are also addressed, for instance: the building site must be cleared of asbestos and the

working areas must be safe/secured.

Actual conditions (e.g. weather, accessibility, construction equipment, transport and logistic processes on-site) related to the planned works are also verified. The outcome of this mapping is used to verify the construction/ refurbishment work planning.

Input for:

- ✓ **Level B:** training dedicated to self-inspection and use of advanced portable systems.

3.2.2 Step 2: Checking of ordered components

Self-inspection at procurement, production and delivery of prefab components is being carried out in step 2.

Actions that are being deployed are: inspection at procurement, production and delivery of prefab components.

- Checking the correctness and conditions of the delivered prefab components, as well as by validating delivery schedules against logistic planning
- Connecting to the 3D product databases from manufacturers and the positions of the components in the BIM model
- In case pre-assembly is done in factory, checking also means pre-delivery product inspection.
- Tests on the quality conformity of the delivered prefab components are performed, including integration of Non-Destructive Testing (NDT) methods if necessary.
-

Input for:

- ✓ **Level B:** training dedicated to self-inspection and use of advanced portable systems.

3.2.3 Step 3: BIM for on-site construction

Modelling of the [existing] building, site and surroundings in Building Information Model (BIM).

When a BIM model of the building does not exist, the existing building will be modelled in BIM, including detailed modelling of the current building and MEP/HVAC components that are critical for building quality and energy performance.

BIM modelling will incorporate available 2D and 3D drawings and documentations of the building, as well as 3D laser scanning and point cloud data processing. Relevant GIS data will be included in BIM; information models of building/MEP components will be aggregated and converted to open-standard BIM.

The BIM model can be viewed on mobile devices on construction site. The BIM model can be viewed on mobile devices on construction site.

Input for:

- ✓ **Level C:** Integration of on-site self-instruction content-objects within the BIM-model
- ✓ **Level D:** Use of Augmented Reality (AR) for on-site self-instruction purposes

3.2.4 Step 4: Generating and deploying BIM-based Augmented Reality (AR)

Generating and deploying BIM-based Augmented Reality (AR) for self-instruction and self-inspection.

- Embedding BIM and VR in Augmented Reality (AR), and extracting BIM / VR process information into 'self-instructions' (e.g. installation manuals and planning schedule) for construction workers on their mobile devices (e.g. iPad); and generating self-instruction modules;
- Interfacing with data output from other inspection hardware (e.g. scanning, imaging and measurement equipment).

Input for:

- ✓ **Level C:** Integration of on-site self-instruction content-objects within the BIM-model
- ✓ **Level D:** Use of Augmented Reality (AR) for on-site self-instruction purposes

3.2.5 Step 5: Clash Detection during construction

Visual validation on-site based on the BIM clash detection performed prior to construction / refurbishment activities.

- BIM-based clash detection is performed before construction/ refurbishment. Found clashes should be resolved by the design/ engineering team, yet the discoveries are recorded to be visualised in AR on-site.
- Review the clash details, and then determine the severity of this clash in several degrees (e.g. from 'easily fixed [human] error' to 'fundamental error requiring redesign').
- If unresolved clashes are still found on-site, trace back the defaulting components and ask these involved actors to perform review and to propose recovery solutions.

Input for:

- ✓ **Level C:** Integration of on-site self-instruction content-objects within the BIM-model
- ✓ **Level D**: Use of Augmented Reality (AR) for on-site self-instruction purposes

3.2.6 Step 6: Self-instruction during construction.

Self-instruction during preparation and execution of construction site and logistics.

- Checking the assembly manuals with support of BIM-based 3D visual instructions.
- Implementing 'self-instructions' to mobile devices of construction workers; providing supervision and support when needed.
- Optimising time and cost schedules (also linked to production planning); analysing risks of delay and budget-overrun; and updating the self-instruction guidelines for construction workers.

Input for:

- ✓ **Level B:** training dedicated to self-inspection and use of advanced portable systems.

3.2.7 Step 7: Self-inspection during construction / refurbishment / maintenance

Self-inspection during construction / refurbishment / maintenance process.

- The workers check the result and quality of the performed works by them according to online / digital check lists

depending on the assembled components.

- When detailed inspections are needed, the specialists will be called in. The sound insulation and U-value will be measured on the building site by means of the procedure developed in INSITER. Thermal and acoustic leakages will be identified using IR camera and SoundBrush allowing to visualise 3D pictures of the building acoustic and thermal field and calculate the sound insulation and the global U-value.

Input for:

- ✓ **Level B:** training dedicated to self-inspection and use of advanced portable systems.

3.2.8 Step 8: Final check

Final evaluation of the work to be delivered. During the final check the measured and inspected deviations are measured against the performance target of the project.

- Completing assignments and reporting on the finished work (for example by including photos).
- The approved work appears on the dashboard showing the level of quality and performance during the on-site process. Quality, time and cost evaluation can be monitored.
- Monitoring and approval or rejection of the reports and the work by the supervisor and project manager.
-

Input for:

- ✓ **Level B:** training dedicated to self-inspection and use of advanced portable systems.

3.3 Development of the ultrasound / ultra-graphics training

Together with DMO and UNIVPM an additional training module for training workers in the introduction and practical application of Ultrasound and Ultra-graphics has been developed. This training module is developed with input from D1.5 and the Delft use case (as presented in D5.3/D5.4/D5.5) and WP2. Support for this initiative from a Dutch pioneer in this field: Gevelscan.

As result from the interview with Gevelscan on these training materials a didactical matrix has been created:

Topics addressed	Knowledge elements (knowing, understanding)	Competence
What is ultrasound & ultragraphy?	Visualization of ultrasonic waves Due to the small wavelength it penetrates easily through cracks in joints. Fewer conditions during inspection than thermography Finding a leakage in a sealing with thermography is more difficult You can work with it all year You can measure preventively during the envelope construction (you can steer with it) Visualise the sound transmission in a construction	Can explain ultrasonic & ultragraphy globally
How does ultrasound & ultragraphy work?	Sending and receiving ultrasound and then plotting it in an image (source and receiver, if the receiver beeps, something is going on) Ultragraphy: you record location and intensity	Can explain globally how ultrasound & ultragraphy works
What is the importance of ultrasonic & ultragraphy in sustaining the built environment?	Thermography and the blower are important quality assurance techniques Why: Energetic, Comfort, Moisture (condensation) The professional must know that and what can be measured ... Location of ultrasound and ultragraphy in addition to Blowerdoor, thermography etc.	Can explain why the use of ultrasound & ultragraphy is relevant to the sustainability of the built environment
Minimal basic knowledge and understanding of ultrasound & ultragraphy?	Sound transfer With ultrasound you catch a wave You also build up an image in Ultragraphy Perform measurements: Ultrasonic - Ultragraphy: Method is the same, the number of components is training Reflections, what are labyrinths, is it harmful to hearing, material ... When do you hear what ... Span What does the device do? When do you do something in the building process & who are involved	Has sufficient basic knowledge and understanding of ultrasound & ultragraphy and when you can apply it
Known pitfalls in ultrasound & ultragraphy?	Misinterpreting images and situations	Can recognise misinterpretations of ultrasound & ultragraphy
Which forms / systems of ultrasound & ultragraphy are there?	Low-rise, high-rise, used equipment	Can distinguish the various forms of ultrasound & ultragraphy
What should you pay attention to when using ultrasound & ultragraphy?		Knows what to look out for when applying ultrasound & ultragraphy
Which actions are relevant to ultrasound & ultragraphy?		Can name the various operations around working with thermography
Which devices / options?	Camera, sound-generator, laptop with visualizing software, sensor	Can identify and name the various devices / options and their function
What innovations are there around ultrasound & ultragraphy?		Knows what current innovations are involved in ultrasound & ultragraphy
Which laws and regulations are important?		Knows globally which laws and regulations apply

Subsequently, in parallel with the Delft demo case, the training content was written. As last step, content was reviewed and fine-tuned together with consortium partners. The content is both published as a **'training-paper'** and as an **e-learning module**.

3.4 Didactical outline for a training on improved thermographic measurement

Together with WP2 partners a didactical outline for a training on improved thermographic measurement has been composed:

Topics addressed	Knowledge elements (knowing, understanding)
What is the technology (generic description)?	Thermography in construction is a diagnostic technique that can provide important indications for the identification of thermal anomalies during the pre-construction and construction phases. Only a thermal camera that can measure the 2D emissivity distribution over the component surface gives the possibility of visualizing thermal bridges and evaluating their influence on building component transmittance. Moreover, this technology can be used in building envelopes to detect heat losses, missing or damaged thermal insulation in walls and roofs, air leakages and sources of moisture.
How does the technology work (in principle)?	The thermal transmittance evaluation is based on integration between experimental data, measured by an IR camera, and numerical data estimated by an analytical model, and therefore it can be called a hybrid method or else Soft Sensing (sensor output combined with software model). The model exploited by the Soft Sensing method, a mono-dimensional model of the building element under test implemented in MATLAB. This method allows improving accuracy and reducing testing time for thermal transmittance assessment of the building envelope element and for the localization of thermal bridges. The thermal bridges are visible on the thermograms acquired by the thermal camera. Their influence on the thermal transmittance of the building envelope can be calculated in terms of envelope thermal transmittance value or energy saving if they are fixed. Difference between INSITER thermography and standard thermography The thermal camera used in the field is for localizing thermal bridges and not for the estimation of thermal transmittance. This is the main innovation of INSITER. The localization of a thermal bridge in a thermogram is very difficult if not possible when a thermal gradient between the two surfaces of a building element does not occur. This is very frequent in building under construction. The design and application of an appropriate forced thermal load is essential to have clear thermograms evidencing inhomogeneities in surface emissivity linked to thermal bridges.
What is the importance of this technology for sustaining the built environment and ensuring quality	The thermal transmittance evaluation of the building components is one of the most important parameters used to classify the energy performance of the building. Problems during construction phase like insulation loss or damages of the building elements is a direct cause of thermal transmittance and energy loss. The technology developed in INSITER allows performing the thermal transmittance evaluation during construction reducing the inspection time with the consequence of increasing the number of surveys. Moreover, the thermal bridges detection and localization allows identifying thermal anomalies and fix them before to deliver the building.
What is the minimal set of knowledge and skills each user needs to have?	The operator must be qualified to use thermal camera. He should have basic skills on building physics for acquisition parameters setting.
Are there different types of this technology and why?	Thermal transmittance can be measured by means thermocouples, heat flux meters. Thermal bridges localization can be performed only via an IR thermal camera.
What are important points you need to address when working with this technology? (to ensure quality)	It is very import to have the correct environmental condition. Thermal gradient between internal and external temperature must be of about 10°C. The environmental condition must have low variation during the measurement time. The thermal emissivity of the surface must be evaluated point by point on the thermal map. Areas with different thermal emissivity must not be considered.

What new skills do users need?	In the post processing phase a medium experience of the operator is necessary to manage data with MATLAB software or other calculation software.
What are commonly made mistakes/errors?	Thermal emissivity evaluation, thermal scale setting on the thermal image.
Can it be applied by workers?	If all the measurement parameters are set a worker can perform series of measurement in the same environment.
What innovations are relevant for users (materials, assembly methods, processes)	Thermography is nowadays used to localise thermal bridges and to measure thermal transmittance of a building envelope element (ISO 9869-2 - 2018) even though the standard method for thermal transmittance assessment is based on heat thermal flux measurement by means of a heat flux meter (ISO 9869 -1). The main difference of the INSITER procedure with respect to the state of the art (ISO 9869-2 - 2018) is that the measurement data are coupled with a simplified mono-dimensional numerical model allowing to reduce the testing time. For this reason, the methodology is called Soft Sensing method, because exploits data obtained from numerical calculation (soft) and sensor measurement (sensing). This method together with a proper thermal load designed to be applied to buildings under construction and not conditioned, allows measuring thermal transmittance in harsh environments and drastically reducing testing time, from days to several hours.
Which laws and regulations are important?	Standard on thermal transmittance in situ evaluation, standard on the energy efficiency level.

3.5 Didactical outline for a training on the microphone array

Together with WP2 partners a didactical outline for a training on the developed microphone array has been composed:

Topics addressed	Knowledge elements (knowing, understanding)
What is the technology (generic description)?	Microphone arrays are used for sound source localisation and reconstruction in a variety of domains, including the identification of noise sources on active structures and devices (engines, vehicles, home appliances, …), contactless characterisation of musical instruments, portable electronics, etc. Commercial solutions integrate a camera within the microphone array in order to provide a map of the sound pressure level superimposed onto the image of the object. In the building sector, the technology is able to detect defects in the junction quality between building components (panels, windows, …) and identify energy leakage in the form of an excess of undesired transmitted sound. The user visualises the sound pressure map together with the visual image in order to identify anomalies.
How does the technology work (in principle)?	The methodology for sound source localisation or reconstruction relies on the knowledge of the properties of sound propagation from the structure of interest to the microphones. A signal processing algorithm incorporates all the microphone recordings and reconstructs the sound field at a distance from them. Processing tools developed within INSITER provide the quantities of interest for building components, namely sound transmission loss and sound prominence ratio. The typical setup consists in placing a controlled sound source behind the component or junction to test.
What is the importance of this technology for sustaining the built environment and ensuring quality	The identification of anomalies in the acoustic behaviour of a building is crucial for assessing its quality and ensuring the stability of the building components and junctions between them. In addition, the acoustic, thermal and geometrical properties of a building are correlated. Thus, the combined use of different inspection tools allows to corroborate and complement the assessment of anomalies.
What is the minimal set of knowledge and skills each user needs to have?	The operator must be qualified to use the microphone array. The person must receive a manufacturers training on the measurement methodology, the interpretation of the results and their incorporation in the inspection and rectification process.
Are there different types of this technology and why?	Sound transmission loss, acoustic leakage detection and sound prominence ratio can be measured with a microphone array and also with a sound intensity probe, as proposed in INSITER. Both devices incorporate location information together with the measured sound pressure or intensity. The difference lies in that sound intensity measurements are more time-consuming but provide the directionality of the sound field, and thus a more precise determination of acoustic anomalies.
What are important points you need to address when working with this technology? (to ensure quality)	It is of crucial importance to perform the acoustic tests in conditions where no sound sources are present other than the controlled sound source belonging to the test setup. Devices that use an optical tracking of their position, such as sound intensity probes, require low light conditions to operate.
What new skills do users need?	The current post-processing tool, as proposed in INSITER, is in a prototype phase, thus requiring the user to be comfortable with running non-compiled software, i.e. scripts.
What are commonly made mistakes/errors?	Errors occur typically when the required environmental conditions are not respected. For instance, if there is ambient noise other than that coming from the controlled sound source, the measurements will be biased towards the location of the disturbance. A common mistake in the case of optically tracked devices is to hasten the calibration stage, therefore resulting in a wrong 3D position of the data.
Can it be applied by workers?	The worker must be trained in order to apply the technology to their work.
What innovations are relevant for users (materials, assembly methods, processes)	Augmented reality devices or ruggedised tablets/laptops are relevant for the visualization of measured data.
Which laws and regulations are important?	The standards on sound intensity measurement and on sound transmission loss evaluation are of relative importance. However, these have been adapted within INSITER to better suit the requirements for on-site inspection and evaluation.

4. Integration of self-instruction within the BIM-model

INSITER develops and provides on-site and BIM-integrated training schemes in addition to conventional training courses approaches.

The (self-) instruction concept is based on several forms of (self-) instruction":

1. with known tools, such as e-learning or toolbox meetings (one-on one or in groups);
2. with training methods referring to BIM, such as explanations of details;
3. with self-instruction modules connected to the BIM, such as self-instruction content available in or linked with the BIM-model;
4. with augmented Reality (AR) on mobile-devices and connected to BIM.

Based on the guidelines and the practical needs of projects a blend of these possibilities is made.
After commissioning the developed BIM connections can also be used for self-instruction for the building occupants: the as-built virtual building model showing the operation manuals of the building –interactively accessible on their mobile devices. In this chapter several ways to integrate or connect self-instruction content in BIM models is described. Research has also been done in WP4 on generating step-by-step self-instruction content. About this a summary from D4.4 is given. Deployment of the self-instruction with AR is described in the next chapter.

4.1 Ways to integrate or connect self-instruction content in BIM models

The self-instruction process aims at providing assembly/construction workers with information to prevent construction errors (product specifications, process description, planning data and relevant know-how information). It also aims at preventing errors during the realization phase by carrying out work 'first time right'. The figure below illustrates which kinds of information could be provided by the INSITER toolset to the construction/assembly worker.

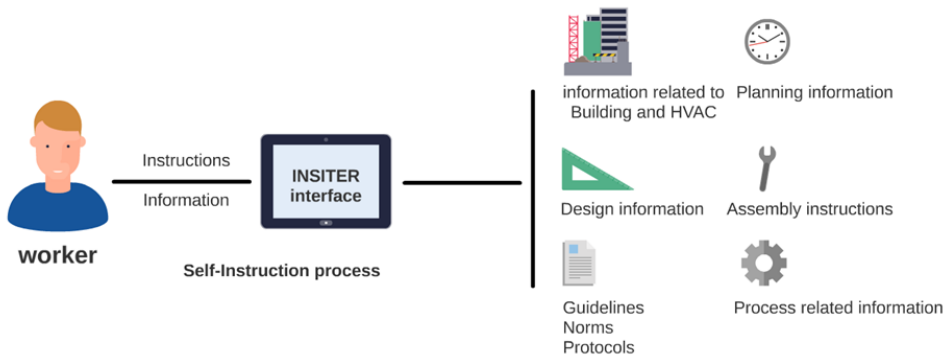


Figure 5: information sources supported by the INSITER toolset

There are several methods to integrate or connect self-instruction content in BIM models.

1. In the model
2. Based on / generated by using information from the BIM model
3. As a highly detailed object in a library
4. Connected to the model using classifications

These methods can be combined to deliver a more effective instruction.

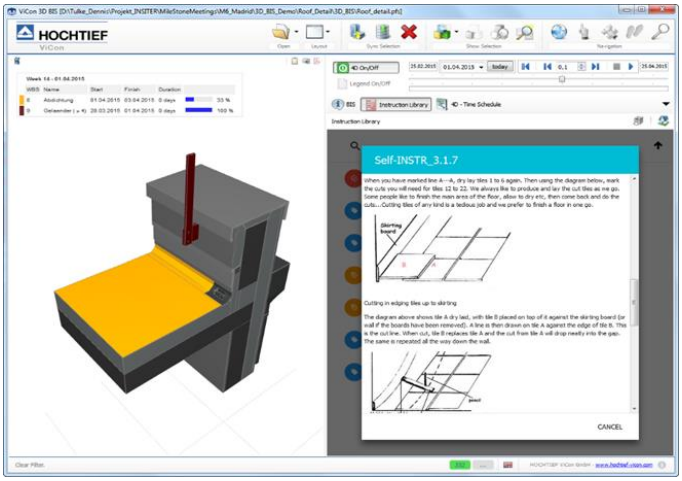


Figure 6: Model of a construction detail and self-instruction

4.1.1 In the model

Self-instruction and self-inspection content can be stored directly into the BIM-model.

This is done on the document-level. For example, in PDF, Word or graphic document-formats.

Figure 7: Storage of self-instruction and self-inspection content on documents level

Within INSITER a SharePoint environment has been used for storage on documents level.

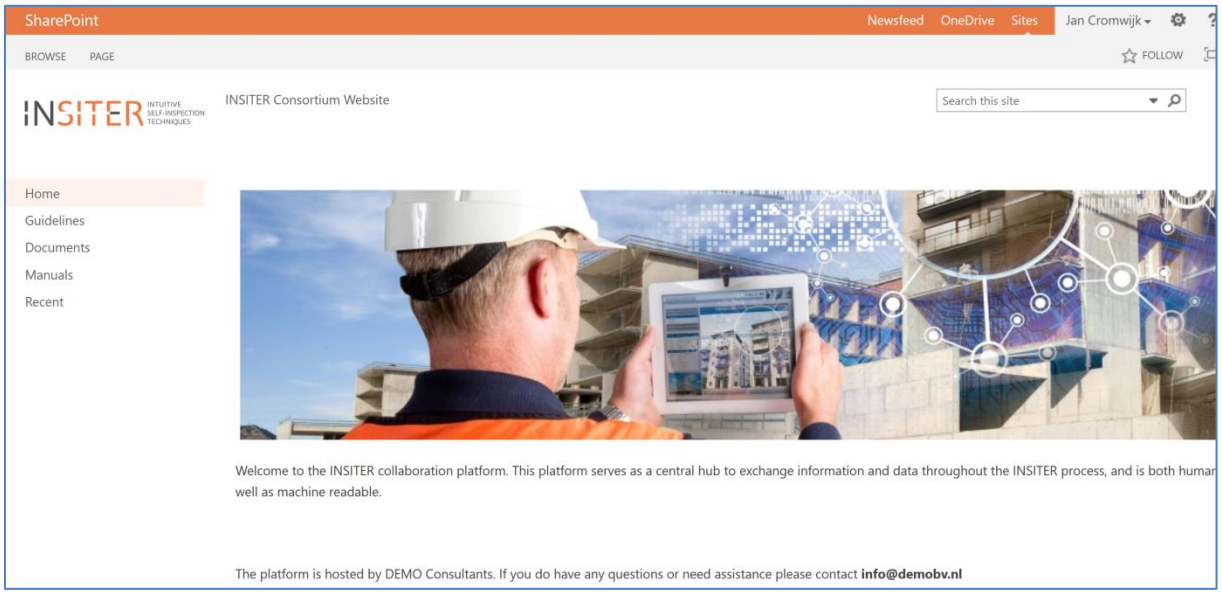


Figure 8: Homepage of the SharePoint environment used to connect documents to the BIM-model

The documents are connected by using the unique GUID's of the elements in the BIM-model, so that exact distribution of documents is possible.

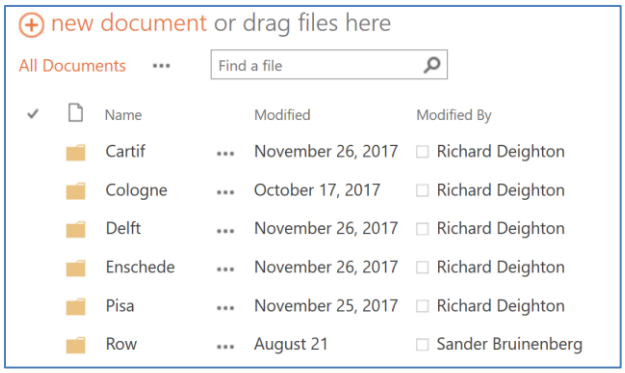
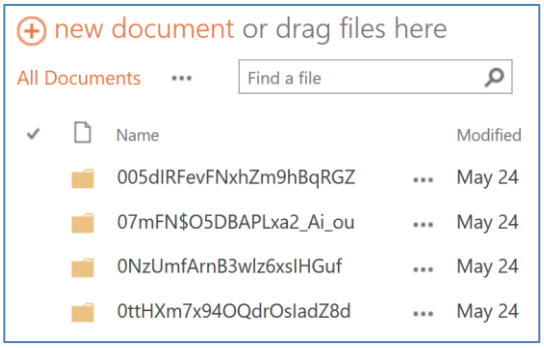


Figure 9: The documents are stored for each project



and connected by using the unique GUID identifiers.

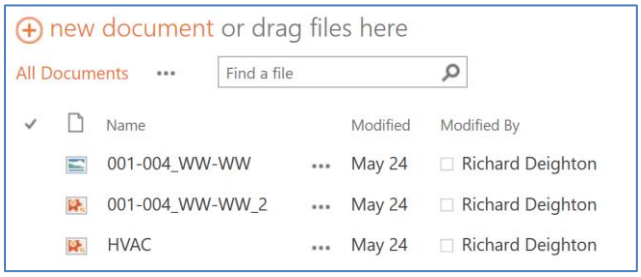


Figure 10: The documents connected to one of the GUIDs

4.1.2 Based on / generated by using information from the BIM model

BIM models which are used for instructions sometimes have to be able to explain workflows. Thus, it will become necessary to create step-by-step (4D) simulations by using those models. This leads to the requirement that the breakdown structure of those models must correspond to the available time schedules. The BIM model must be able to visualise the process steps for the purpose of Self-Instructions.

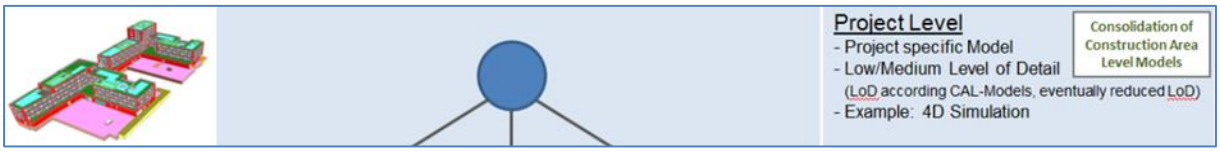


Figure 11: Self-instruction content generated with 4D information from the BIM-model

Construction process simulations and dynamic visualizations can be realised by the linking of BIM 3D CAD model objects to a construction time schedule. The result is the 4D simulation of planned construction activities utilizing 3D CAD objects.

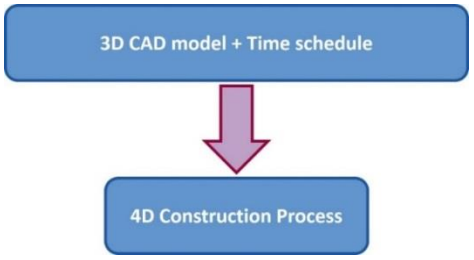


Figure 12: Combining 3D CAD Objects and Time Schedule Information to generate 4D Simulations

4.1.3 As a highly detailed object in a library

Self-instruction content can be created in the form of highly detailed objects, sometimes even with 4D information inside. Based on the details step by step instructions can be created. Both as 4D simulation as proven in D2.1 and as step by step 3D self-instruction with AR. The latter is further explored in D4.4 and summarised in the paragraph 3.2.

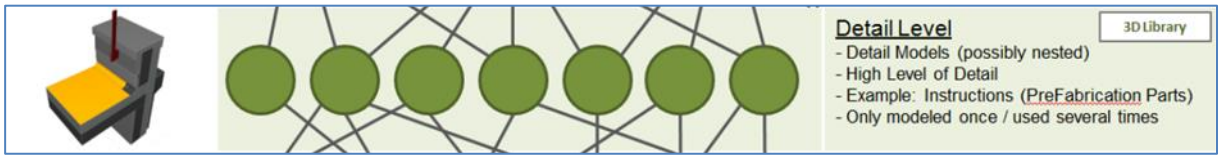


Figure 13: Self-instruction content from a 3D library

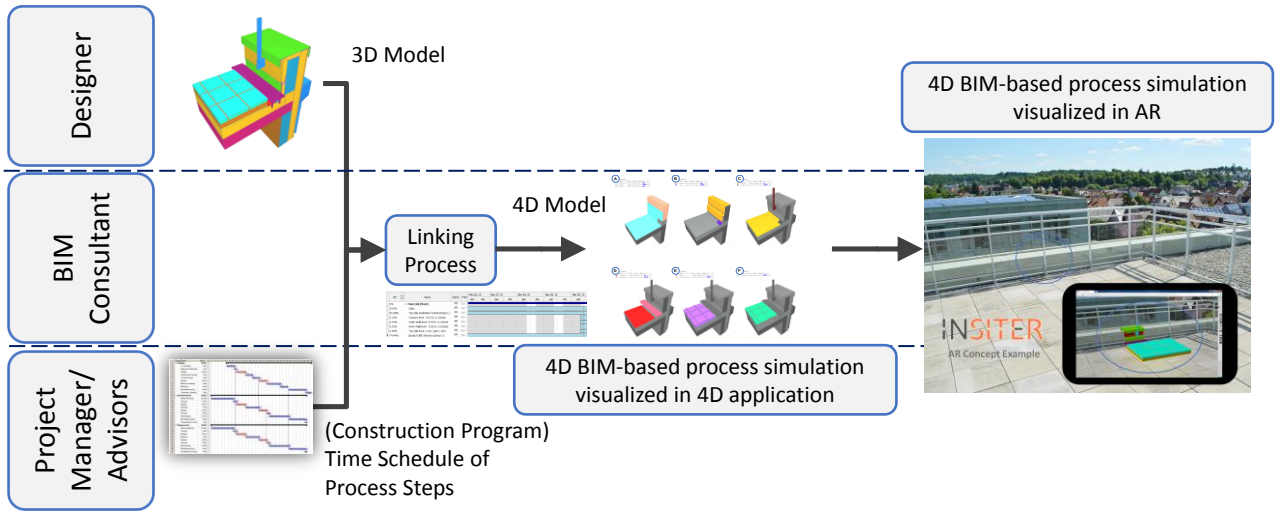


Figure 14: Simulation of BIM-Based Construction Process for Self-instruction in AR

4.1.4 Connected to the model using classifications

By using classifications connected to BIM-models can be connected with object specific, task related and person specific self-instruction or self-inspection content. By creating taxonomies describing tasks and subtasks that have to be performed by workers or professionals. BIM classification systems are the common basis for digitalised cooperation in construction, operation and maintenance to increase efficiency through enhanced exchange of information. For example, if a supplier adds self-instruction content to a product, this self-instruction content can be automatically linked to all the instances of that product in a BIM-model, in order to ensure that the content is always available and up-to-date.

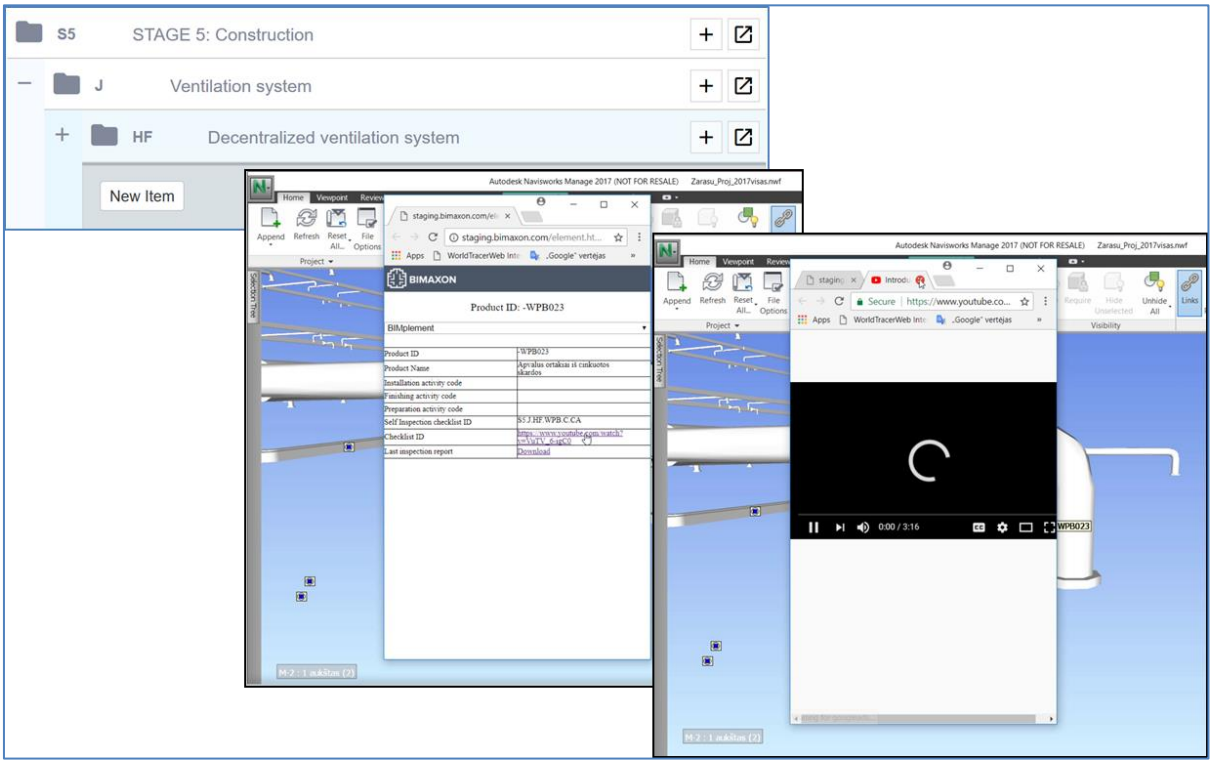
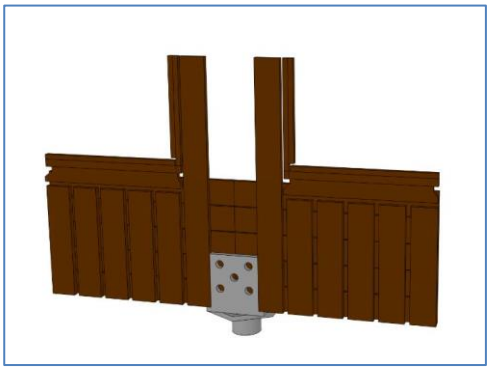


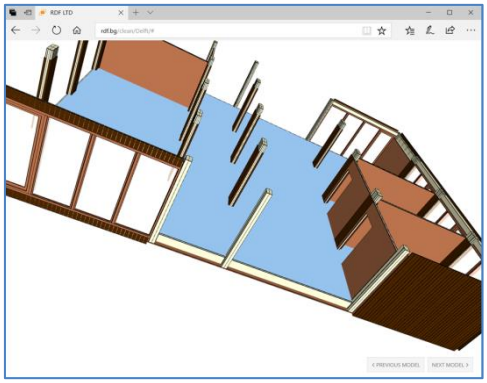
Figure 15: Self-instruction content from a 3D library

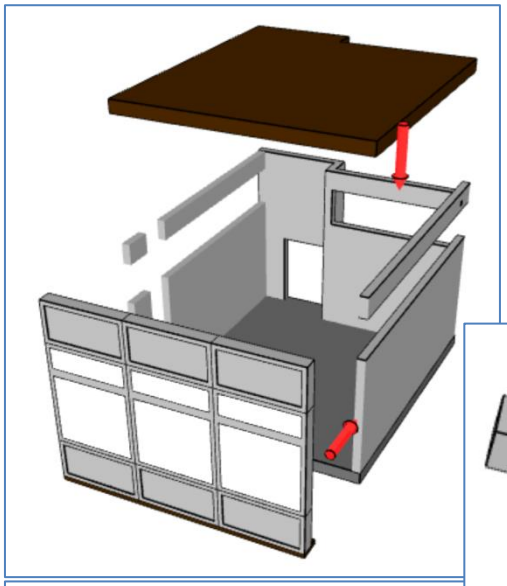
4.2 Generating and deploying BIM-based step-by-step instructions

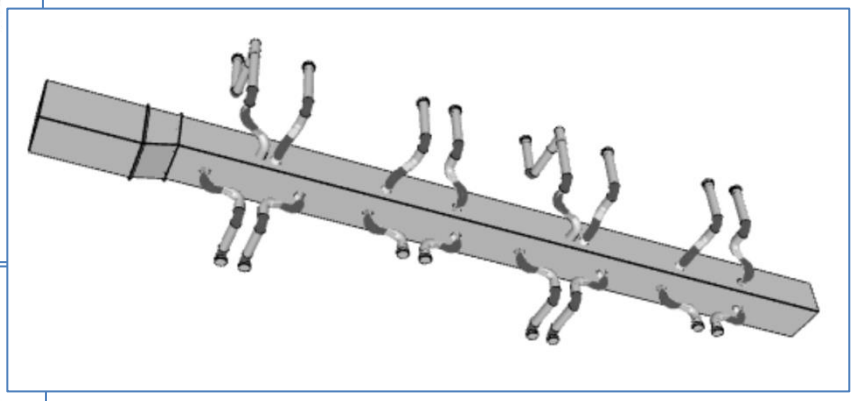
In WP4 (D4.4) software concerning the development and presentation of (offline) 3D self-instruction content on mobile devices has been developed. As preparation desk research was performed focusing on companies like IKEA, toy manufacturers like LEGO and CUBORO. These organizations clearly put a lot of effort in research on how to present their self-instructions to the end user. For them is a major task to enable very clear and unambiguous solutions for self-instruction manuals. That is why their approach and experience was considered as important start point in the creating of 3D self-instruction content. Also input from smaller companies focussing on professionals has been reviewed for completeness. Functionality found in the different solutions has been embedded as much as possible in the 3D self-instruction solution from INSITER. To demonstrate the functionality demonstrations of technological possibilities have been drafted.

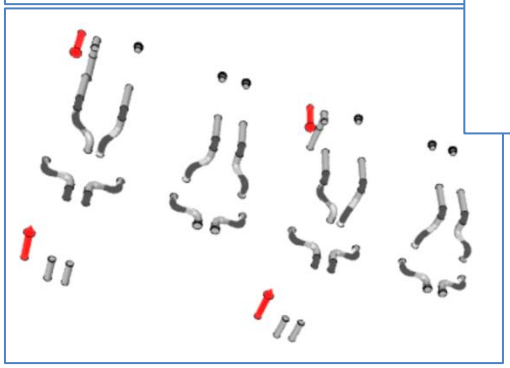


In combination with WP5 (pilots) two additional examples have been developed for the Enschede pilot case.









5. Use of Augmented Reality (AR)

In this chapter the use of Augmented Reality for self-instruction purposes is summarised. Within task 2.1 “Process simulation and Augmented Reality systems“, several INSITER Augmented Reality systems are defined, setup, developed and demonstrated. For more information check deliverable D2.1.

- **Construction processes** concerning HVC roof construction including AR concept (HVC and FhG)

Figure 16: INSITER “Roof Construction” AR concept example concerning construction process simulation

- **Construction or refurbishment processes** concerning UNIVPM cooling room including the **AR visualization concept of instrumentation devices data** within an AR pilot case application (UNIVPM and FHGIPA).

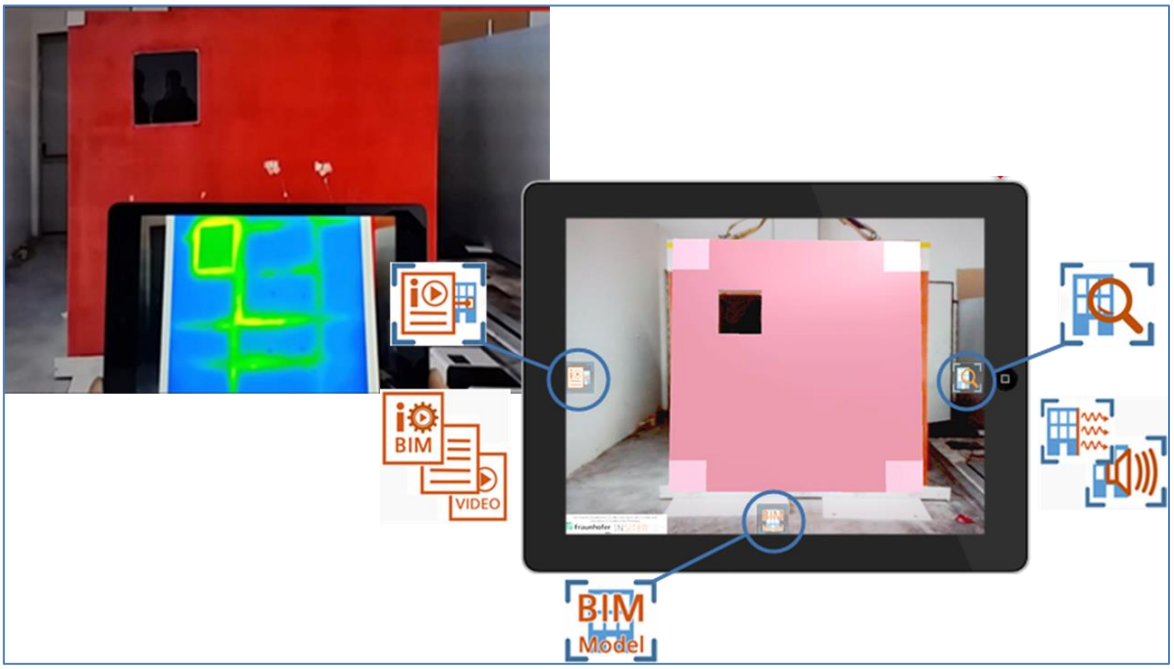


Figure 17: INSITER “AR visualization concept of instrumentation devices data” example

-

- Demonstration of MEP/HVAC systems and **maintenance visualization example** in connection with AR pilot case application (FhG) (A: Complete BIM-model, B: Current Installation Status, C: New Pipes to be Installed)

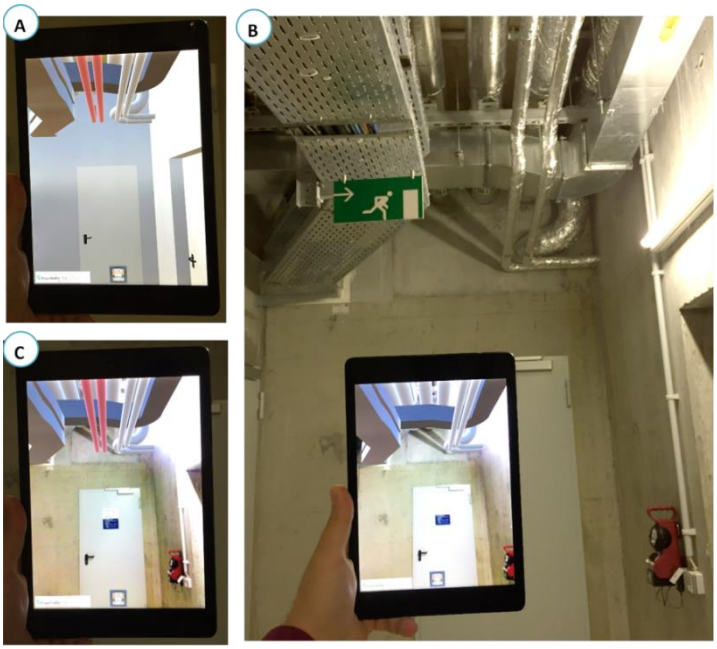


Figure 18: AR Showcase in connection with HVAC MEP Systems

6. Development of an INSITER community of practice

This chapter documents the development of a community of practice around INSITER. It addresses the following elements:

- Setting up an EU-wide community of practice to learn from proven practice. Including connection with existing “BUILD UP Skills” & “Construction Skills” programmes to exchange training modules for skilled workers.
- Adding self-inspection and working with the INSITER tools to qualification schemes for involved occupations

6.1 A community of practice to learn from proven practice

In year 3 and 4 a community of practice around the INSITER project results is seeded. The goal of this community of practice is gathering practical knowledge and building up experience with self-inspection and coupled with on-site instructions. Networking activities have found several other EU-projects targeting inspection of nZEB quality. Connections are made with the H2020 BUILD UP Skills projects BUStoB, PROF/TRAC, NET-UBIEP, ACCEPT, BUILD2SPEC and BIMplement. In the next table an overview of these projects and exchanges made is given.

Project name	Exchanged in year 3	Exchanged in year 4
BUStoB - 649737	1. Specifications of the database format used to document building and installation errors 2. Usage of the in BUStoB developed approach to develop the e-learning module for awareness training	1. Re-use of the in INSITER documented inspection protocols. 2. Dissemination of the INSITER module for training awareness. 3. Used the BUStoB approach for developing the module on Ultrasound / Ultra-graphics 4. Using the BUStoB didactical matrix approach for defining Qualifications
Description: BUILD UP SKILLS ENERGY TRAINING FOR BUILDERS NL	BUStoB developed a methodology to create and disseminate small e-learning modules concerning the basics of technologies involved in sustaining the build environment. The modules are disseminated in the BUILD UP Skills advisor app. This app also has an innovative functionality to learn from documented building and installation errors. In INSITER documented errors and inspection protocols can be re-used for training craftsmen.	

Project name	Exchanged in year 3	Exchanged in year 4
PROF/TRAC - 649473		1. Exchange on BIM and INSITER related Unit of Learning Outcomes to strengthen the INSITER qualification 2. Using the PROF/TRAC platform for dissemination (of the training modules)
Description: PROF/TRAC	PROF/TRAC developed a train the trainer programme for nZEB design and realisation of nZEB projects. Also, a qualification framework for describing qualifications needed for professionals is developed. INSITER results can be added to that framework, to embed (self-)inspection activities into the qualification.	
ACCEPT - 636895		1. Comparison of AR techniques between INSITER and ACCEPT and Built2spec (described in D5.7)
Description: ACCEPT	ACCEPT is developing three Apps that are intended to assist a reduction of the well-documented Performance Gap and improve overall quality and knowledge transfer in construction sites. Apps are developed for use on Smart Glasses, tablets and laptops.	
NET-UBIEP - 754016		1. Exchange on BIM and INSITER related Unit of Learning Outcomes to strengthen the INSITER qualification for implementation and to strengthen the NET-UBIEP results
Description: NET UBIEP	The Net-UBIEP Project will increase energy performance related competences of six professional figures: BIM evaluator, BIM facility manager, BIM manager, BIM coordinator, BIM expert and BIM user. This by developing and implementing BIM Qualification Models to tackle the problem of energy competences gap in the existing buildings sector as a whole. Each BIM Qualification Model will be composed by a BIM Training Scheme and a BIM Qualification and Certification Scheme	

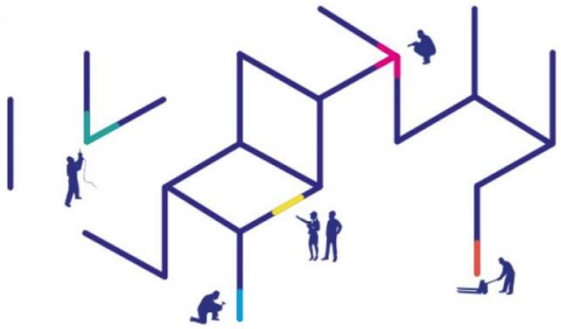
Project name	Exchanged in year 3	Exchanged in year 4
BUILT2SPEC - 637221	1. ISSO has contacted the Dutch BUILT2SPEC partner TNO	1. Exchange about the developed Airtightness Test Tools with air-pulse checks 2. Exchange about the structure of the guidelines and inspection checklists 3. Comparison of AR techniques between INSITER and ACCEPT and Built2spec (described in D5.7)
Description: BUILT2SPEC	BUILT2SPEC develops multiple new and innovative on-site quality assurance tools such as: • 3D and Imagery Tools • Building Information Modelling (BIM) • Smart Building Components • Energy Efficiency Quality Checks • Indoor Air Quality Tools • Airtightness Test Tools with air-pulse checks • Thermal Imaging Tools • Acoustic Tools These tools are connected to a Virtual Construction Management Platform supporting the collection and sharing of all project data, from initial design to the delivery. https://www.youtube.com/watch?time_continue=85&v=5rhoatxMysM	
BIMplement - 745510	1. Example of a task-based classifications linked to BIM-model	1. Exchange about the use of tasks-based classifications to automate the coupling of self-instruction content to a BIM-model
Description: BIMplement	BIMplement: Towards a learning building sector for enhanced quality control by setting up a large-scale and flexible qualification methodology integrating technical, cross-trade and BIM related skills and competences, implemented with hands-on BIM enhanced workplace learning tools, with as ingredients: 1. Cross-trade: multi-disciplinary 2. Cross-level: white- and blue-collar workers 3. Enhanced Quality Control enabled by BIM as universal information carrier 4. Hands-on BIM workplaces and learning tools	

INSITER takes part in platforms such as ECTP, buildingSMART and BUILD UP.

ENERGY EFFICIENT BUILDINGS
AN ECTP COMMITTEE FOR INNOVATIVE BUILT ENVIRONMENT

buildingSMART

http://www.buildup.eu/en/explore/links/insiter-project



To enable the train the trainer schemes and addition of self-inspection to the qualification schemes we use the in BUILD UP Skills developed methodology for composing so called didactic matrices for the awareness (1) and usage (2) 'trainings'. The developed training content on self-inspection is being disseminated using the BUILD UP Skills advisor app and the aNewSpring LMS. In this app also links can be made to available training courses in the EU. This catalogue has a community feedback tool based on social ratings in the self-instruction app.

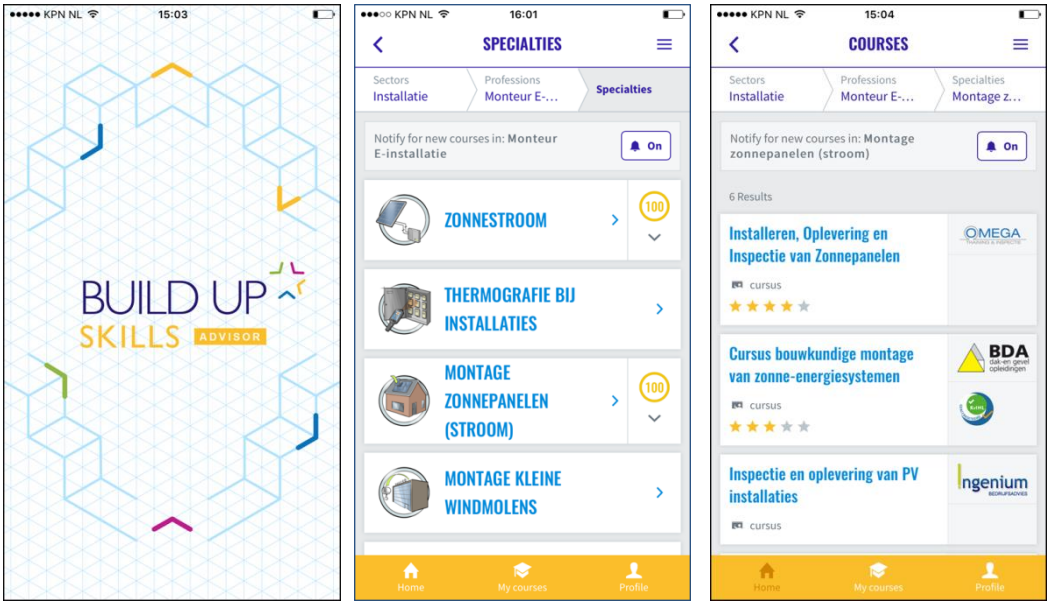
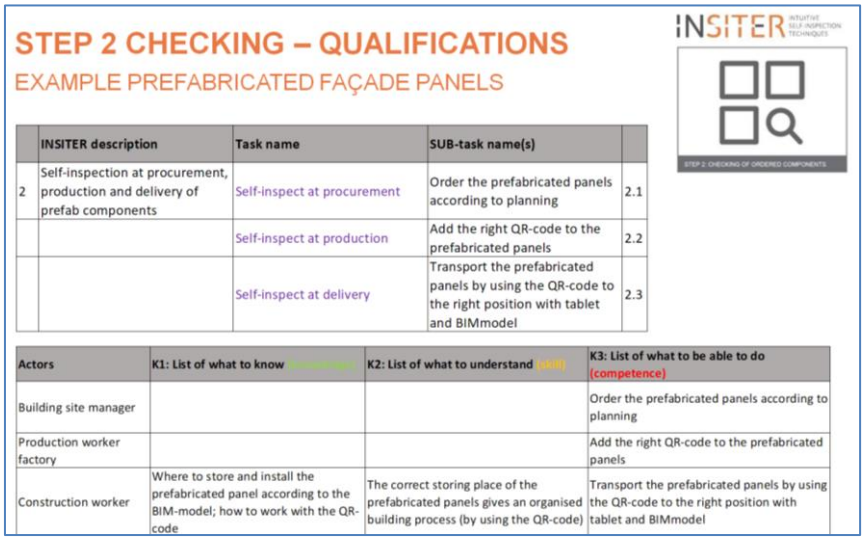


Figure 19: some screenshots from the Dutch BUILD UP Skills-app implementation

6.2 Preparation of training and certification programmes

In the last year of the INSITER project a skill-oriented professional training and certification programme for continuing professional development of involved occupations has been prepared. This is done in the form of a Qualification that describes the competences, knowledge and skills in the form of Unit of Learning Outcomes. This qualification is first developed from a use case 'quality assurance of a façade'. After assessing applicability of the NET-UBIEP and PROF/TRAC competences we decided to develop also a generic INSITER Qualification on BIM enabled Quality Assurance (Annex 8).



STEP 2 CHECKING – QUALIFICATIONS

EXAMPLE PREFABRICATED FAÇADE PANELS

	INSITER description	Task name	SUB-task name(s)	
2	Self-inspection at procurement, production and delivery of prefab components	Self-inspect at procurement	Order the prefabricated panels according to planning	2.1
		Self-inspect at production	Add the right QR-code to the prefabricated panels	2.2
		Self-inspect at delivery	Transport the prefabricated panels by using the QR-code to the right position with tablet and BIMmodel	2.3

Actors	K1: List of what to know	K2: List of what to understand	K3: List of what to be able to do (competence)
Building site manager			Order the prefabricated panels according to planning
Production worker factory			Add the right QR-code to the prefabricated panels
Construction worker	Where to store and install the prefabricated panel according to the BIM-model; how to work with the QR-code	The correct storing place of the prefabricated panels gives an organised building process (by using the QR-code)	Transport the prefabricated panels by using the QR-code to the right position with tablet and BIMmodel

Exchange with PROF/TRAC

In the PROF/TRAC project a minimal Qualification was defined for Quality assurance. For application of the INSITER method and tools more specific competence descriptors are required. Therefor we developed in WP6 an INSITER Qualification on BIM enabled Quality Assurance (Annex 8). This is shared with the PROF/TRAC team.

PROF / TRAC

Back to "EU minimum skill levels"

Technology Nr.								
IS4		Quality assurance	Taking responsibility in assuring quality of its own work; Being aware of the consequences of actions on the energy performance of the NZEB building and the building process; Being able to implement and assess self-inspection methodologies; Skills on commissioning and maintenance					
Project phase (if applicable)	Short description (to be used in the advisor app)	Detailed description of skills	for skill level(s)					
			1	2	3	4	5	
Pre design	Define QA criteria to ensure energy and IEQ performance	Define measureable QA criteria with appropriate data input, according to customer needs to ensure nZEB energy and IEQ performance.						
Design	Apply QA criteria in design phase	Apply the defined QA criteria in the design phase. Integrate the means of QA measurement and monitoring in the design, using BIM and BAC where applicable.						
Tender	Define QA monitoring methodology	Define the QA monitoring methodology with measureable QA criteria as part of the contract						
Realisation	Manage QA during realisation	Apply quality management according to the agreed QA methodology throughout the realisation phase						
Commissioning/use	Monitor QA data and manage performance gaps	Measure and analyse the defined QA input data, define and manage performance gaps						

DEFINITION OF THE SKILL LEVELS	
0	Not applicable / no knowledge and skills required
1	Has little knowledge and skills with respect to the relevant field / technology (mostly *outside* the own field of expertise). Understands basic principles and is able to take part in project team discussions
2	Understands basic knowledge and has practical skills within the field / technology, is able to solve simple problems by selecting and applying basic methods, tools, materials and information (mostly *outside* the own field of expertise)
3	Has comprehensive, factual and theoretical knowledge and skills within the field / technology, is capable of solving standard problems within the field
4	Has advanced knowledge involving a critical understanding of theories and principles and skills, required to solve complex and unpredictable problems in the field and is aware of the boundaries
5	Has specialized knowledge and problem-solving skills, partly at the forefront of knowledge in the field, in order to develop new knowledge and procedures and to integrate knowledge from different fields

Figures 20, 21: The original PROF/TRAC qualification content on Quality Assurance

Exchange with NET-UBIEP

In the NET-UBIEP project a 3D Qualification matrix addressing BIM-skills in relation with nZEB-skills is developed. To validate this matrix, the competences and actors from the INSITER Qualification have been cross-referenced with the NET-UBIEP Qualifications and actors. The NET-UBIEP qualifications are quite well documenting BIM-skills and competences in general. For application of the INSITER method and tools more specific competence descriptors are required. Therefor we developed in WP6 an INSITER Qualification on BIM enabled Quality Assurance (Annex 8). This is shared with the NET-UBIEP team.

NET UBIEP
Network for Using BIM to Increase the Energy Performance

List of Competences

Technician

N	Competence
C0	Have basic BIM knowledge and skills
C0.K1	BIM basic concepts, terminology, principles, strategies and its value proposition
C0.K2	Benefits and uses of BIM compared to traditional methods for improving energy efficiency of new or existing buildings
C0.K3	Project information development cycle: information specification, development, exchange and maintenance throughout all the
C0.K4	Reasons for open and interoperable solutions to ensure collaboration among professionals of different disciplines
C0.K5	Methodology to identify, plan, develop and evaluate organization's BIM implementation capabilities and BIM uses
C0.K6	Relevance of maintenance for maintaing the foreseen energy performance
C0.S1	Read a BIM Execution Plan (BEP)
C0.S2	Read a Information Delivery Manual
C0.S3	Identify information requirements for his own role
C0.S4	Identify the format to read information and transfer information within the supply chain
C2	Apply information management
C2.K2	Principle of data transferring among different software and/or data federating into an integrated design
C2.K3	Principle of data security and administrative law in the archiving of data in a CDE (Common Data Environment)
C2.K4	Principle of information management in building sustainability and lean design
C2.S1	Manage and coordinate information related to energy performance

Figure 22: Example of a Qualification from NET-UBIEP

ANNEX 1: Structure of knowledge transfer means

In this annex several outlines for types of knowledge transfer means are given. These outlines are focussed on enabling the use of in INSITER developed training content in other applications and EU-projects.

Template for documentation of building errors

In WP 1 the INSITER network was scanned for existing documentation on building errors. Multiple sources have been found. Each source has its own way or format to describe building errors. At this moment there is no national or EU standard for documenting building errors. This hampers effective knowledge transfer. Therefore, a template for documentation of building errors is developed. This template is focussed on creating a standard for documentation of building errors. ISSO also uses this template to link documented building errors to a protocol for on-site quality inspections.

- Situation
  - Short descriptive name (technical error description)
- Good execution (n-items) (Educational goal: to recognise correct execution)
  - Short description of correct execution
  - Photo(s) of correct execution
    I. Short description of why this photo is showing a correct example
  - Short and easy to understand explanation of theory behind the example
- Incorrect execution (n-items) (Educational goal: to recognise incorrect execution)
  - Short description of incorrect execution
  - Photo(s) of incorrect execution
    I. Short description of why this photo is showing an incorrect example
  - Short and easy to understand explanation of theory behind the example
- Possible negative effects (n-items) (Educational goal: to recognise damage & link it)
  - Short description of the damage
  - Photo('s) s of negative effect(s)
    I. Short description of the damage on the photo
  - Short and easy to understand explanation of theory behind the example
- Possible complaints (n-items) (Educational goal: to recognise complaints & link it)
  - Short description of the complaint
  - Photo('s) s illustrating the complaint
    I. Short description of the complaint on the photo
  - Short and easy to understand explanation of theory why the complaint is a result of incorrect execution
- How to solve during execution (n-items) (Educational goal: learning to solve execution errors)
  - Short instruction
  - Photo(s)

I. Short description of the instruction on the photo

- How to solve after execution (n-items) (Educational goal: learning to solve found errors)
  - Short instruction
  - Photo(s)
    I. Short description of the instruction on the photo
- How to prove during construction
  - Short instruction
  - Photo(s)
    I. Short description of the instruction on the photo
- How to prove after construction (inspection)
  - Short instruction
  - Photo(s)
    I. Short description of the instruction on the photo

Some screenshots of an environment using the above described template.

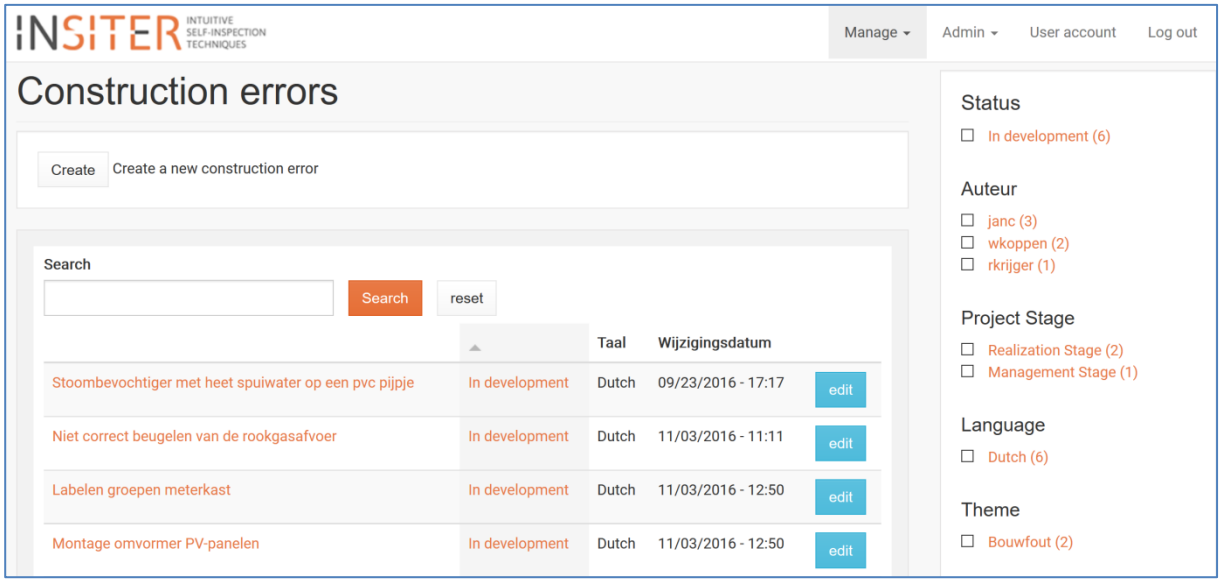


Figure 23: Database for documenting construction errors using the INSITER description template

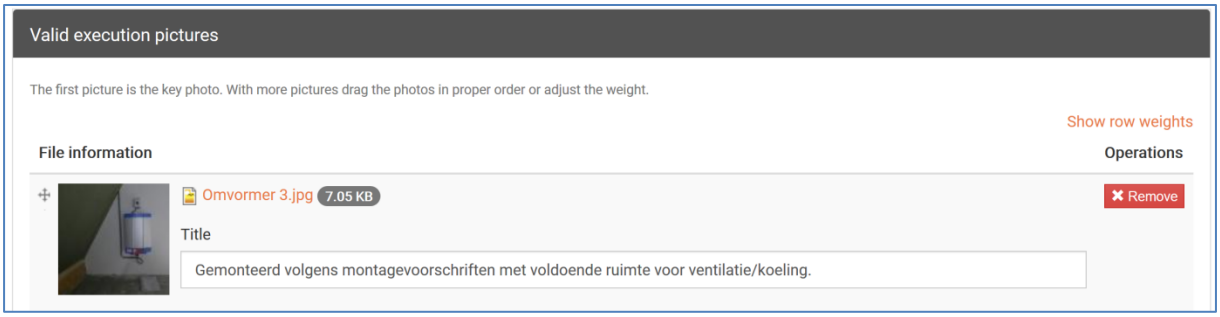
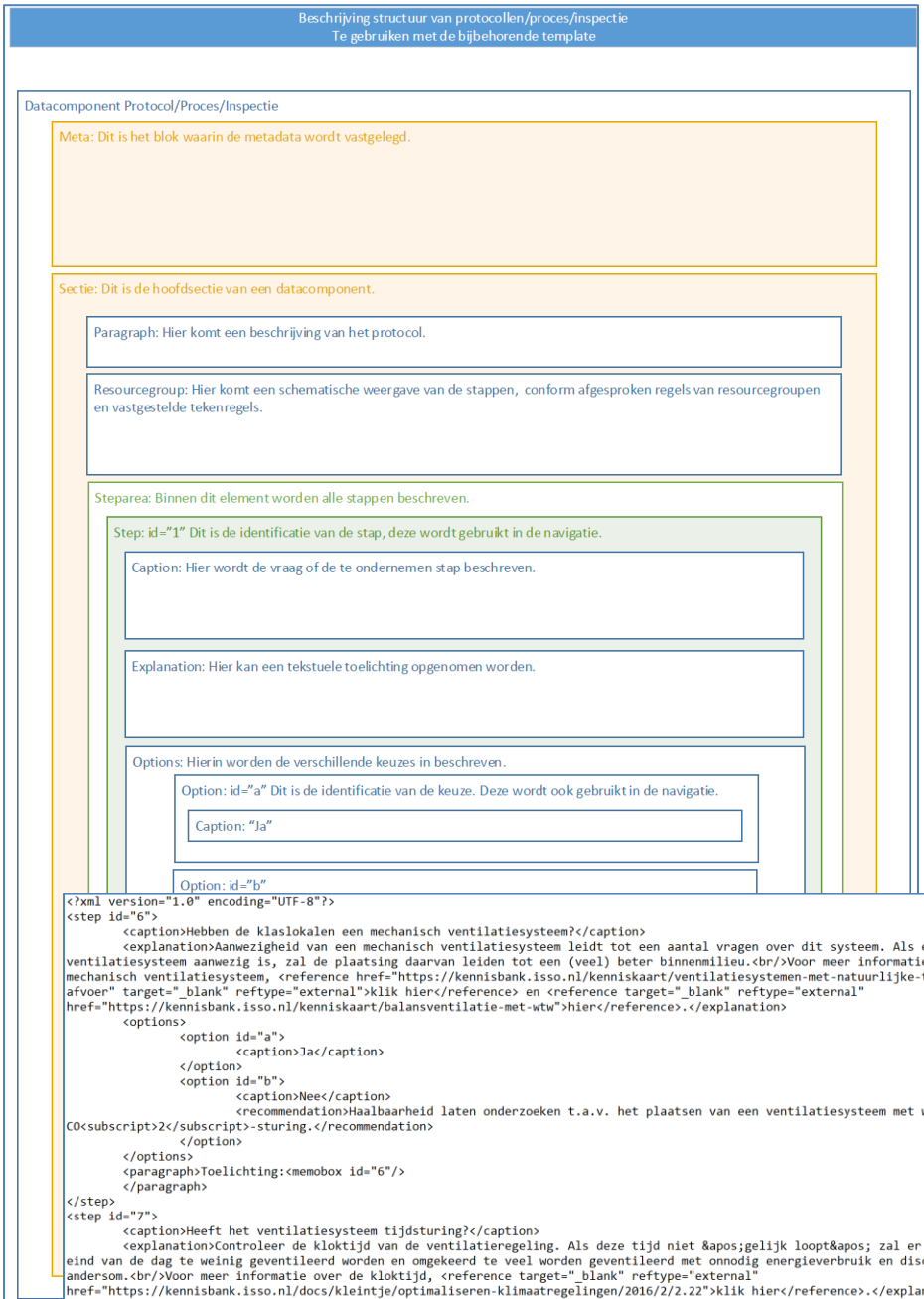


Figure 24: Adding a valid execution photo

Template for inspection protocols

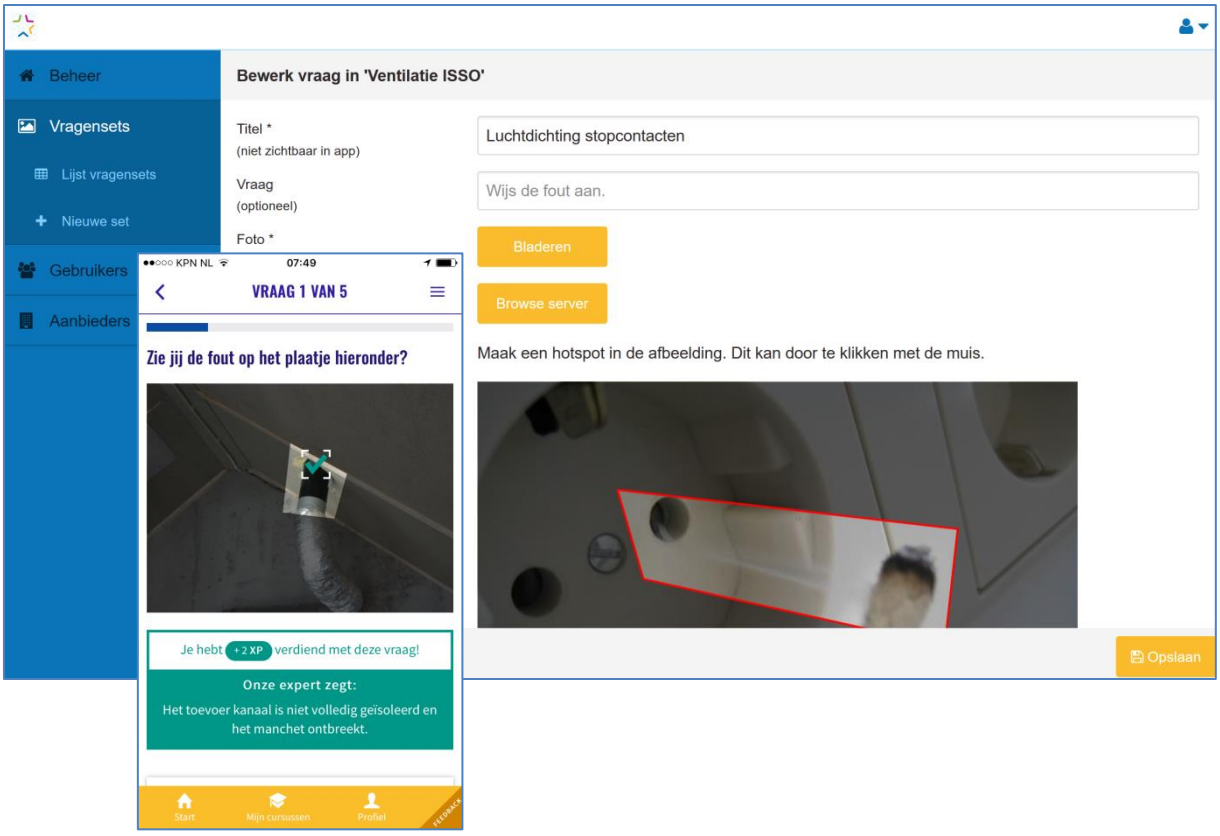
To enable exchange of in INSITER developed inspection protocols (part of the guidelines) an XML structure for inspection protocols is drafted.




```
<?xml version="1.0" encoding="UTF-8"?>
<step id="6">
        <caption>Hebben de klaslokalen een mechanisch ventilatiesysteem?</caption>
        <explanation>Aanwezigheid van een mechanisch ventilatiesysteem leidt tot een aantal vragen over dit systeem. Als er geen mechanisch
ventilatiesysteem aanwezig is, zal de plaatsing daarvan leiden tot een (veel) beter binnenmilieu.<br/>Voor meer informatie over het herkennen van een
mechanisch ventilatiesysteem, <reference href="https://kennisbank.isso.nl/kenniskaart/ventilatiesystemen-met-natuurlijke-toevoer-en-mechanische-
afvoer" target="_blank" reftype="external">klik hier</reference> en <reference target="_blank" reftype="external"
href="https://kennisbank.isso.nl/kenniskaart/balansventilatie-met-wtw">hier</reference>.</explanation>
        <options>
                <option id="a">
                        <caption>Ja</caption>
                </option>
                <option id="b">
                        <caption>Nee</caption>
                        <recommendation>Haalbaarheid laten onderzoeken t.a.v. het plaatsen van een ventilatiesysteem met warmteterugwinning en
CO<subscript>2</subscript>-sturing.</recommendation>
                </option>
        </options>
        <paragraph>Toelichting:<memobox id="6"/>
        </paragraph>
</step>
<step id="7">
        <caption>Heeft het ventilatiesysteem tijdsturing?</caption>
        <explanation>Controleer de kloktijd van de ventilatieregeling. Als deze tijd niet &amp;apos;gelijk loopt&amp;apos; zal er aan het begin of aan het
eind van de dag te weinig geventileerd worden en omgekeerd te veel worden geventileerd met onnodig energieverbruik en discomfort tot gevolg. Of
andersom.<br/>Voor meer informatie over de kloktijd, <reference target="_blank" reftype="external"
href="https://kennisbank.isso.nl/docs/kleintje/optimaliseren-klimaatregelingen/2016/2/2.22">klik hier</reference>.</explanation>
                <options>
                        <option id="a">
                                <caption>Ja</caption>
                        </option>
                        <option id="b">
                                <caption>Nee</caption>
                                <recommendation>Ventilatiesysteem voorzien van tijdsturing.</recommendation>
                        </option>
                </options>
        <paragraph>Toelichting:<memobox id="7"/>
        </paragraph>
</step>
```

Figure 25: Example of an XML-file of an inspection protocol

Example of re-use of the documented and stored building errors in the BUILD UP Skills advisor app (H2020-BUStoB-649737).



Outline for software and hardware manuals

Manuals for software and hardware can (if needed) be developed by using the following outline:

1. GENERAL INFORMATION
   - 1.1 Goals and description of [NAME OF THE TOOL]
   - 1.2 Organization of the manual
2. GETTING STARTED
   - 2.1 Register and login
   - 2.2 Starting
3. STEP BY STEP INSTRUCTIONS FOR USING [NAME OF THE TOOL]
   - 3.1 Building model
   - 3.2 General Settings
     - 3.2.1 XXXX
     - 3.2.2 XXXX
     - 3.2.3 XXXX
     - 3.2.4 XXXX
   - 3.3 Simulation
   - 3.4 Calibration
   - 3.5 [ANY OTHER FUNTIONALITY / FEATURE]
4. EXAMPLE / PILOT APPLICATION / PRELIMINARY RESULTS

ANNEX 2: THE AWARENESS TRAINING MODULE

ANNEX 3: THE ULTRASOUND/ULTRA-GRAPHICS MODULE

Annex 3a in Dutch

Annex 3b in English

ANNEX 4: THE INSITER IMPLEMENTATION TRAINING

ANNEX 5: THE INSITER IMPLEMENTATION TRAINING

SYLLABUS

ANNEX 6: INSITER PRESENTATION WORKSHOP ENSCHEDE

ANNEX 7: INSITER & QUALITY ASSURANCE

ANNEX 8: INSITER QUALIFICATION ON BIM ENABLED QA

INSITER Qualification on BIM enabled Quality Assurance

ANNEX 9: INSITER Process Chart V3.5