BIMplement

Towards a learning building sector by setting up a large-scale and flexible qualification methodology integrating technical, cross-craft and BIM related skills and competences.

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Report:	**Overview of possibilities to connect the tools and learning methods to the BIM**
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1. Introduction

This deliverable is part of Task 3.4 Implementing into learning tools and learning methods by connecting them to the BIM models & processes.

In this task the results of the tasks 3.1 to 3.3 will be integrated in BIM models and processes, i.e., BIM will be used as a carrier of information of skills, trainings and tools for (in this case) the selected topics: ventilation and infiltration. If needed the actual software implementation within the selected tools and learning methods will be performed. This can include for example connecting databases with learning content to the BIM-model(s) and the selected learning tools.

Which are on their turn input for the experimental sites where they will be used in Task 4.3 “Configuring tools, learning methods, and qualification schemes” fit for use on the experimental sites. In Task 4.3 the tools, the learning methods and the qualification schemes will be connected to the projects defined in the pilot field labs and the experimental sites, this in order to improve the quality of the involved white and blue collarworkers and thus, improving the overall quality of the construction process.

Based on the project needs, the level of BIM implementation and the nZEB-challenges in the selected projects scripts for successful implementation of the developed means will be written, discussed and implemented. Based on 50 projects this will lead to an inventory of BIMplementation scripts, including experiences with these scripts. These scripts will be part of the BIMplement guide.

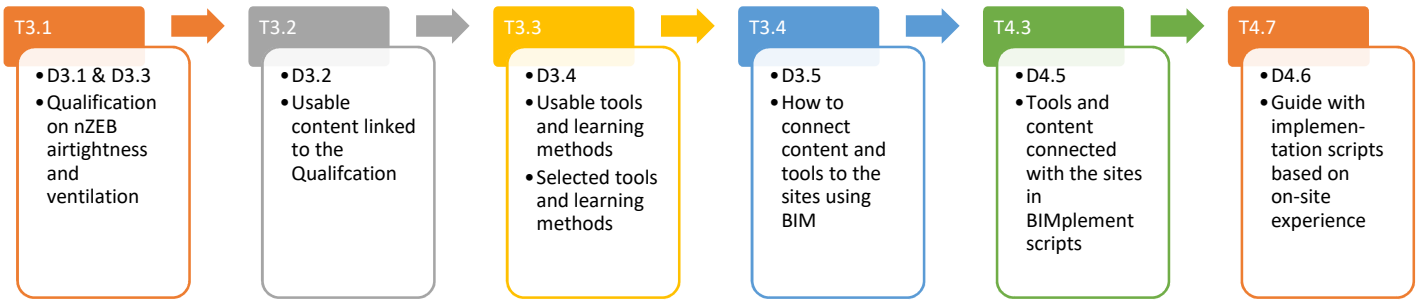


Figure 1: From Qualification -to- a tool selection -to- implemented tools -to- usable implementation scripts

2. Setup of this deliverable

Withing BIMplement we will apply existing BIM-Learning Tools and learning methods to enable professionals and workers to:

- Upskill themselves just-in-time and just-in-place
- Creating learning loops in projects and between projects
- Creating moments for cross-trade 'clash-moments' / 'Action Learning'

In D3.4 a selection of tools is made by each country for use on the experimental sites. In D3.5 **an overview of possibilities to connect the tools and learning methods to the BIM models & processes is given**. This overview will be based on existing experience and on experience that is build up **during the implementation of the selected tools and learning methods in the pilot fieldlabs**.

The overview can include connecting to databases with learning content to the BIM-model(s) and the selected learning tools.

Experiments in the Pilot Field labs

As there is not much experience available on the connection of learning and inspection content with BIM-models usable for blue collars. Experiments will be defined and performed in cooperation with the BIMplement pilot fieldlabs.

To test the methods for connecting the selected tools and learning methods a small script has to be followed.

Steps	What to describe	
Step 1	What tool will be used?	Example: A BIMviewer to view a building detail on site for step by step guidance to blue collars involved
Step 2	What will be tested?	Example: An IFC-viewer will be used to show a building detail with the step-by-step information
Step 3	What are the requirements for the BIM-model (and what adaptations are needed)?	Example: The right element names need to be used..
Step 4	What technical modifications or steps where needed?	Example: A connection to the database with the Building details needs to be made
Step 5	Is the solution tested usable for usage at the experimental sites	A small explanation of the usability. **Important:** The process description and the results of the Pilot fieldlabs are documented more extensive in D4.6.

3. Results from France

3.1 Overview of methods to connect the selected tools and learning methods

Two main tools will be experimented in France. They both will be implemented through specifically design training sessions for blue collar workers:
1) related to on-site practice of airtightness and ventilation skills with Praxibat mobile training center
2) related to on site use of BIM models

In addition a research pilot fieldlab will be developed to use the IfcOpening Object for a better implementation of airtightness on site.

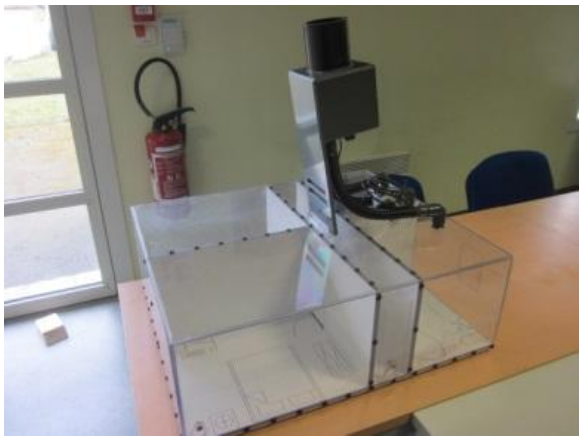
1. PRAXIBAT and mobile training center

As presented in D3.4, a PRAXIBAT mobile platform will be installed directly on pilot and experimental building site in order to bring the training place on site.

In fact, In France, it has been established that craftsmen and small size companies (SME's) do not wish to waste their time going in training centers. Yet, even though these training centers have been specially organized and equipped to answers the needs of professional staff, and not those of students or apprentices. It is really difficult to convince the small size building companies to send their employees, and in particular Blue collar workers, in these places.

The mobile training center will be used to display and explain, hands-on, what are the technical solutions and good practices to implement airtightness and ventilation systems on site. Weak points in terms of airtightness and ventilation will be identified and shown using the BIM-model.

Both foremen, site managers and blue collar workers will be invited to participate in training sessions that are specifically designed for them. During these sessions, the trainees will manipulate the devices, implement different product on real full size case studies, and on the building site.



Ventilation mock-up

airtightness training in the mobile PRAXIBAT centre

This very original type of pedagogy aims at offering another way to bring skills to building companies staff, mainly blue workers, who actually and presently do not benefit of the possibility the legislation offer them to up-skill their practices. Because CONSTRUCTYS (see D3.3) considers that this type of training sessions will improve the practice skills of small companies and craftsmen, it will finance the use of the mobile training centers in the training sessions that will be labelled in 2019.

2. develop the use of BIM on the construction site

a) on-site BIM use,context in France

In France, design of BIM models is extensively implemented in project managers and architect agencies. This means that construction project are designed using BIM to answers the needs of the designers only.

Once the BIM model has reached the final design, in general, it appears that there is no more use of it ! This means that, in most cases :

- when the project manager does not ask the building companies to create their own trade BIM model, the building companies do not have access to this BIM model to answer the call for bid,
- when the project manager requires a BIM model from building companies (structure, MEP, joinery),
    - 1) the other building companies involved in the construction do not have access to this model, and
    - 2) those who design their own trade BIM model, do not transfer it to their own on-site workers.

The present situation in France, is that in a large majority of cases, there is no use of BIM models on the construction site, especially when small and medium size companies and craftsmen are employed.

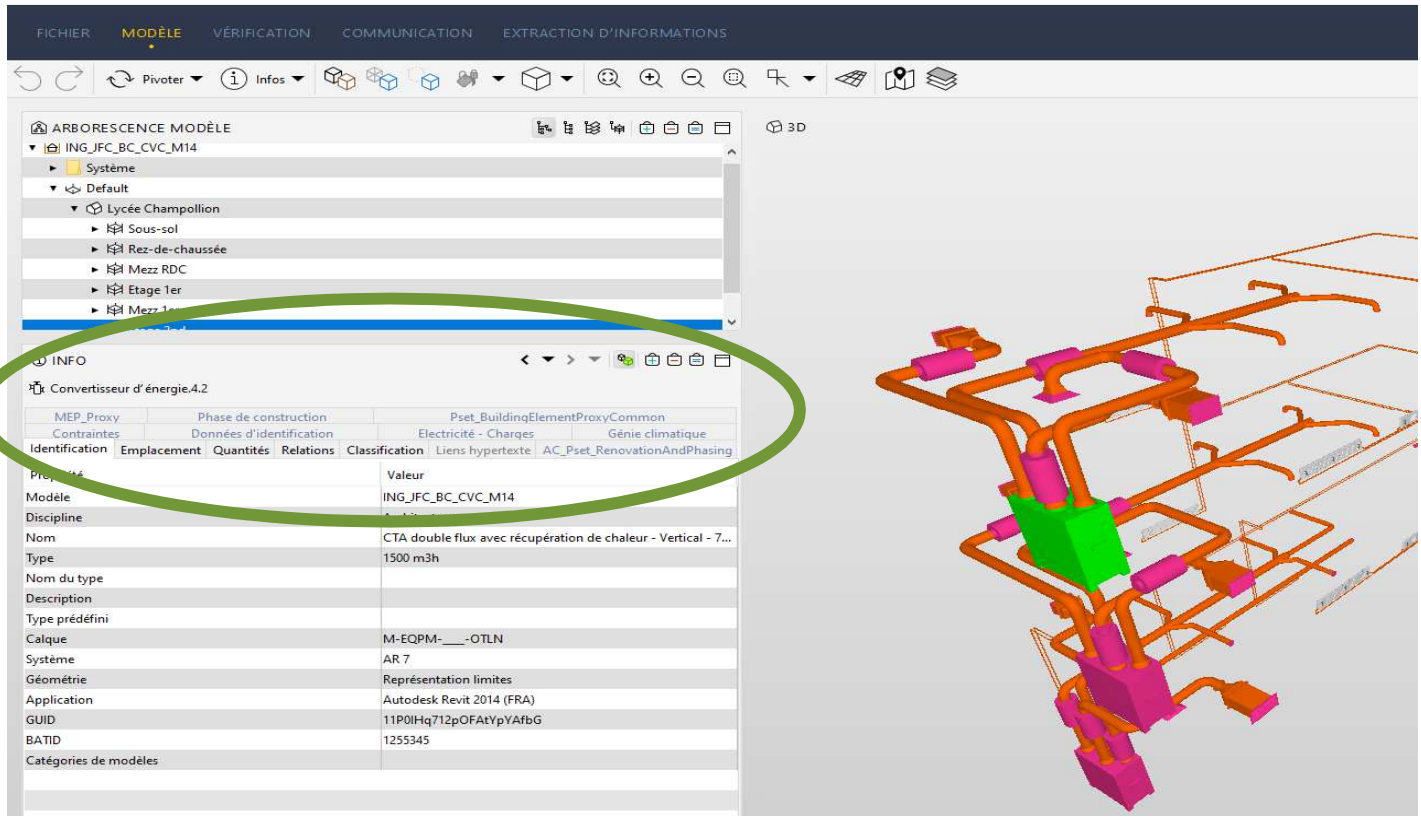
b) Pilot fieldlab to “develop the use of BIM on the construction site”

The aim of this pilot field lab will be to introduce the use of BIM on site, by blue collar workers, in order to achieve a better quality implementation, in particular with ventilation and airtightness.

The means to be implemented are mainly training sessions dedicated to the whole stakeholders chain, and adapted to their actual skills, knowledge and needs. These session will be realized on site, with the project stakeholders, and following a very precise and deep analysis of the project BIM model (see example in D4.5).

Different aspects will be tackled, chosen among the following depending of each pilot project.

- convince ALL stakeholders of the interest of BIM, that is : client, project manager team and architects, building companies management team, design office
- and convince them that the use of BIM is most important on the construction site for site managers, foremen and blue collar workers
- explain to the design office what information should be includes for a better implementation on site, and where to place them
- train on-site workers how to use freeware viewers to get a better representation of the work to be implemented and of the data they will find attached to it, to to use communication tools to get additional information.
- set on-site means to use BIM, such as on-site computers and tablets.



Visualization of a ventilation system with a BIM model

A detailed presentation of the tools to be used is given in D3.4, and of the training content (D4.5)

The training method started to be implemented on 3 pilot projects in France : Zodiak (Arras), Carrousel (Dijon), dwellings (Voreppe).

3. development of “IFC Opening Object” for a better airtightness implementation

a) context

The BIM process that creates BIM models is adapted to almost any kind of construction system and building issues … but airtightness. In fact, there exist NO IfcObject related to airtightness. This means that, contrarily to ventilation for which it is possible to list and assemble any IfcObject that constitute the whole ventilation network, it is not, at the present time, to include, in a formal way, objects and products

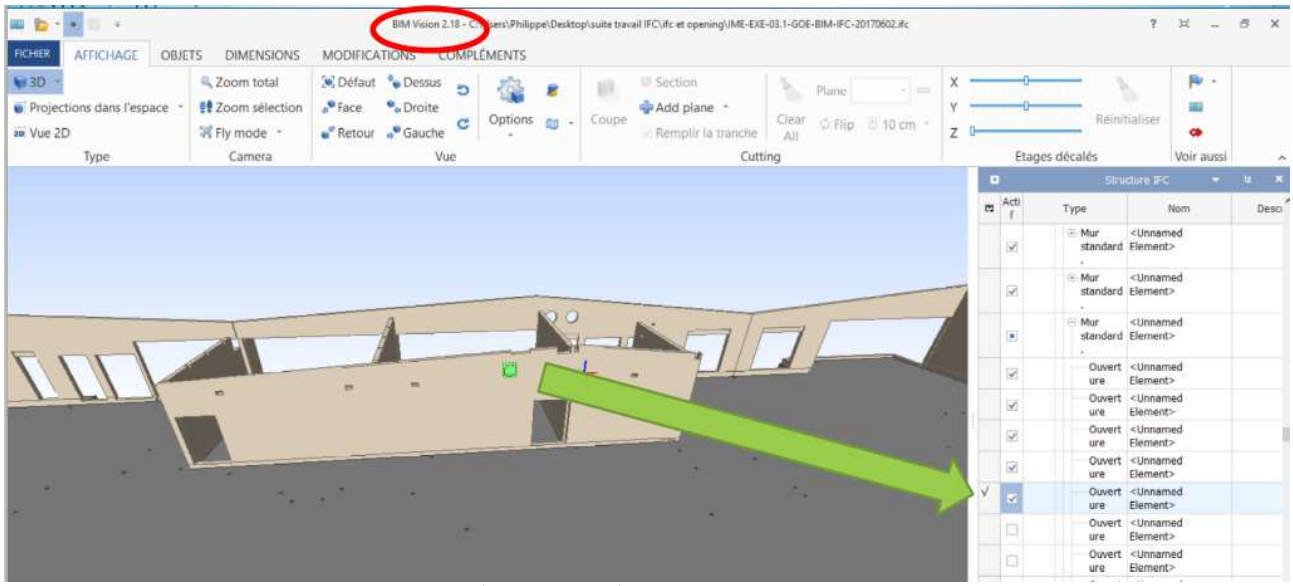
The objective of this research pilot field project will be to be able to display airtightness issues within a BIM model. To answer this challenge, the project will find means to check the airtightness weak points, with a special IfcObject : the “ifc_opening”.

This object exist already and are used to make holes in an IFC_object such as : door and window in a wall, blockout for pipes … As for airtightness, the main troubles appear around “holes” : joinery and blockout for pipes. So each time there is a hole that has to be airtight, there is an IfcOpening that has been created in the BIM model.

The expected results of this pilot field project will be to be able to use the “IfcOpening” element, as a carrier for information on “how to implement a good quality airtightness”.

b) expected development

IfcOpening are created by all BIM design commercial software. The trouble comes from the fact that they are not visible with all viewers .



IfcOpening (ouverture) identified with BIMvision

The first part of the pilot field project will consist in exploring the faisability of two types of soltions :

- Attach documents to IfcOpeningElement
  - These IfcOpening could be linked to a BFC note, or an attached document that would explain and present, for each weak point, what is the solution that has been designed by the design office.
  - The attached document could also be a 2D-plan where holes are identified , as well as the solutions and airtightness products that have been foreseen by the design office.
- Attach hyperlinks to IfcOpeningElement
  - sort all solutions related to airtightness and document the related solutions
  - create a numerical file that gather all these solutions
  - enter the internet hyperlink in the BIM model. Clicking on this tab will orient the user to the files with the technical documents related to this opening

The second part of the project will consist in assessing the viewers capacities to display opening objects and their data.

- The main issue to be worked out is that not all freeware viewers are able to display these IfcOpening,
- and only a few viewers can actually identify them as BIM objects.

c) Pilot fieldlab description

This experiment will consist in implementing both previously proposed solutions. One possibility will also to build a specific airtightness BIM model in order to test under which conditions it will be more efficient for on-site implementation.

The research project will be implemented in collaboration with Illbruck industrial company and also with some software companies. It will consist in :

- analyse all viewers capacities to display and use opening objects

- analyse the way IfcOpening have to be used in native BIM models for these object to be usable in viewers
- apply the §8.3 solutions to different models realized with different commercial design software for a variety of project and analyse the solutions when using different viewers
- test these solutions on a set of BIMplement experimental projects.

3.2 Experiments in the Pilot Field labs

1.PRAXIBAT mobile center

The PRAXIBAT mobile center consist of carrying into the construction site all pedagogical devices needed to improve the blue collars workers practices in the field of ventilation and airtightness.

Normally, these training devices are found in dedicated training center. But often, both company managers and workers feel most unconfortable in a classroom, and are afraid to waste their time, both because of generic training and because of transportation time.

Bringing training devices on site, and implementing training session applied to their own project issues, make is more convenient for companies and workers.

Steps	What to describe	
Step 1	What tool will be used?	A Praxibat container will be installed on the construction site. It contents several didactic devices to train on implementation of airtightness solutions and ventilation devices
Step 2	What will be tested?	On site training program for blue collars who, in general, have no access to training sessions.
Step 3	What are the requirements for the BIM-model (and what adaptations are needed)?	All weak points in terms of airtightness and ventilation have to be identified. Technical solutions have to be treated by the design offices and attached/linked to the model.
Step 4	What technical modifications or steps where needed?	A dedicated space to install the container A site organization for all workers to be allowed to participate in the training during their working time
Step 5	Is the solution tested usable for usage at the experimental sites	This experimental device has already been tested on a very few number of sites? Bimplement will be the occasion to multiply the number of on-site tests.

2.Pilot fieldlab with BIM-model as didactic tool

This pilot fieldlab will consist in bringing, directly on the working site, and with the help of an adapted training program and coaching, the possibility to up-skill blue workers practice by 3D visualizing the work they have to implement, instead of the classical and often unreadable 2Dplans.

It will also aim at bringing data and information on products to be implementated right from the model, instead of having to search for them in different paper documents, if available.

Steps	What to describe	
Step 1	What tool will be used?	BIM model freeware viewers to : - give a global vision of a project to on-site workers - navigate in a BIM model to find accurate information - give feed back and comments to other stakeholders
Step 2	What will be tested?	On the construction site training session for blue collars workers, dedicated to the use of BIM during the execution phase
Step 3	What are the requirements for the BIM-model (and what adaptations are needed)?	The project manager has to be convinced of the interest of using BIIM on the construction site. The design offices have to design the BIM models (or create a specific BIM model) and include proper data for its use by blue collar workers A site organization for all workers to be allowed to participate in the training during their working time
Step 4	What technical modifications or steps are needed?	All weak points in terms of airtightness and ventilation have to be identified. Technical solutions have to be treated by the design offices and attached/linked to the model.
Step 5	Is the solution tested usable for usage at the experimental sites	This training program will be conducted on several French pilot and experimental project and on site assessment of added value will be documented

2. Experiment with using IFC-Opening for adding airtightness information to BIM-models

As for airtightness, the issue is very different.

On one hand, all trades are concerned with this question, not just a few, like with ventilation. On the second hand, there does not exist, up to now, any BIM object that describes the product used for airtightness. This means that a BIM model cannot include the specific product compulsory for a good airtightness.

However: there is a very little used BIM object, called “IfcOpeningElement”, that could be used to concentrate all information related to each opening, be it a window in a wall, a pipe through a roof, an electrical wire through an airtightness membrane ...

During the BIMplement project, experiments will be done to check the conditions under which these special BIM objects could be used.

Steps	What to describe	
Step 1	What tool will be used?	BIM model analysis with viewers and commercial software
Step 2	What will be tested?	Capacity of - visualizing IfcOpeningObjects - attaching documents or links to this object Test of possible solutions on real projects
Step 3	What are the requirements for the BIM-model (and	Collaboration of the design office to introduce data, information, documents, technical links … to a set of

	what adaptations are needed)?	IfcOpening where an airtightness issue has been identified
Step 4	What technical modifications or steps are needed?	Identification of a set of airtightness weak points, and elaboration of technical solutions to answer these issues Introduction/attachment of data to the corresponding IfcOpeningObjects Test of different viewers to check the ability to access these data Test the interest to create specific airtightness BIM models to gather all identified weak points and corresponding solutions.
Step 5	Is the solution tested usable for usage at the experimental sites	The solution will be usable if a simple process can be implemented, both at the level of design office and at the work site level.

4. Results from The Netherlands

4.1 Overview of methods to connect the selected tools and learning methods

1. Getting BIM-information TO the building site

A building can be designed with nZEB specifications, but during construction, there are a lot of organisations involved. If their activities aren't well aligned or they aren't qualified/competent, for instance airtightness quality will suffer from that.

Main contractors usually hire subcontractors to do parts of the work. These subcontractors are instructed just before starting and their results are (randomly) inspected. For the main contractor, it is essential the subcontractors understand what they need to do and that they feel responsible for delivering the expected quality.

Therefore, the subcontractors need to receive the correct information and understand the consequences of their work. If, for example, the company responsible for sealing the window frames is out of sealant and decides to leave the last 10 centimeters be, the airtightness suffers. Because quality control is done randomly, it might be overlooked. And during project delivery when a blower door test is performed, this leak will come to light and the company might have to come back to fix the problem. This is not a rare situation, it happens more often than expected.

The main contractor can address this challenge in several ways:

1. if he can provide his subcontractors with specific and up to date information,
2. if he can use this information in his quality control process,
3. if he can help his subcontractors by specifying which qualifications they need for certain tasks.

The information specified above can be part of the IFC model, when the correct object parameters are modelled or with linked information.

Tools/methods: QF (3.3), training, BIM-viewers, reference details, step-by-step instruction manual

2. Getting BIM-information FROM the building site

To perform their tasks, workers need information and need to have a certain set of competences. Both of these 'inputs' are often implied with blue collar workers and there is no knowledge on how to improve worker competencies with the use of (BIM) information.

Most of the time workers are given too much (irrelevant) information needed for them to perform their task(s). It is not uncommon for them to sift through several (2D) drawings to get the right idea of how certain elements need to be constructed. Thus, they have to derive the relevant information themselves with a higher risk of misinterpretation.

Also, sometimes they are given too little (specific) information, so as a result, they have to fill in the blanks themselves and with again risks of misinterpretation. The drawings usually consist of floor plans, views from all major directions and cross sections for complex interfaces. Also, there are manuals, instructions, guidelines for components. All these separate pieces of information need to be represented as a coherent set of relevant information.

A separate issue is that blue collar workers rarely have a good understanding of their qualifications, qualification needs and their development. The common frame of mind is, if

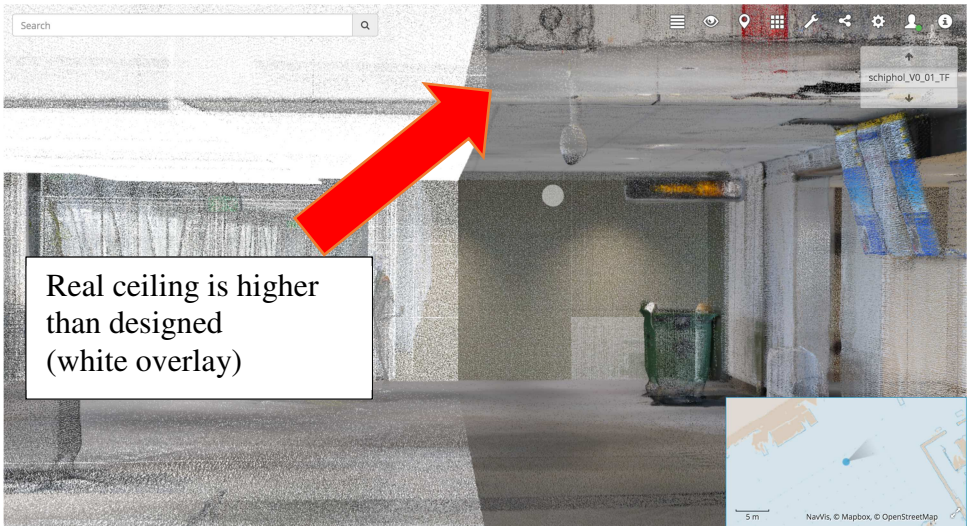
you do something often enough, you will become good at it eventually. It is a kind of organic way of skill development, whereas the sector may need a more structured way also.

White collar workers can be helped with insight in required competences, to understand the (information) needs of the blue collar workers so they can adjust/add to the IFC models to fit the blue collars' needs.

Tools/methods: modelling software, QF (3.3), basic object information a/o properties, additional product information, BIMaxon (flowing the lead of Lithuania)

3. Improving the Quality processes with BIM

Quality Assurance (QA) is managing and improving processes in order to deliver a quality product or service. Using BIM based information in the work flow will give a better insight in the (information) needs and requirements of the tasks and thus of the process. Quality Control (QC) is measuring the properties of a product or service to a certain quality standard. The quality standard can be derived from the BIM model. Next to basic geometry a BIM model often obtains other (non-graphical) information, such as materialization, color, product types and such. On-site inspection is the actual measuring of the work. This can be done via a visual inspection by the quality worker, whether or not supported by digital aids. Or it can be done digitally (as shown below), where an IFC model is compared to a point cloud of the real time situation.



Comparison between as-built (point cloud) and as-designed (IFC model) Source: Royal Schiphol Group

A situation that often occurs in a construction project is that a (quality) problem arises and that a solution is implemented on-site. Not often are the consequences of the solution checked nor are the results fed back to the model. The end result is that revision drawings are often inaccurate and process improvements are not implemented in the organization for future projects.

Tools/methods: modelling software, QC/QA software, digital inspection methods, checklists

4.2 Experiments in the Pilot Field labs

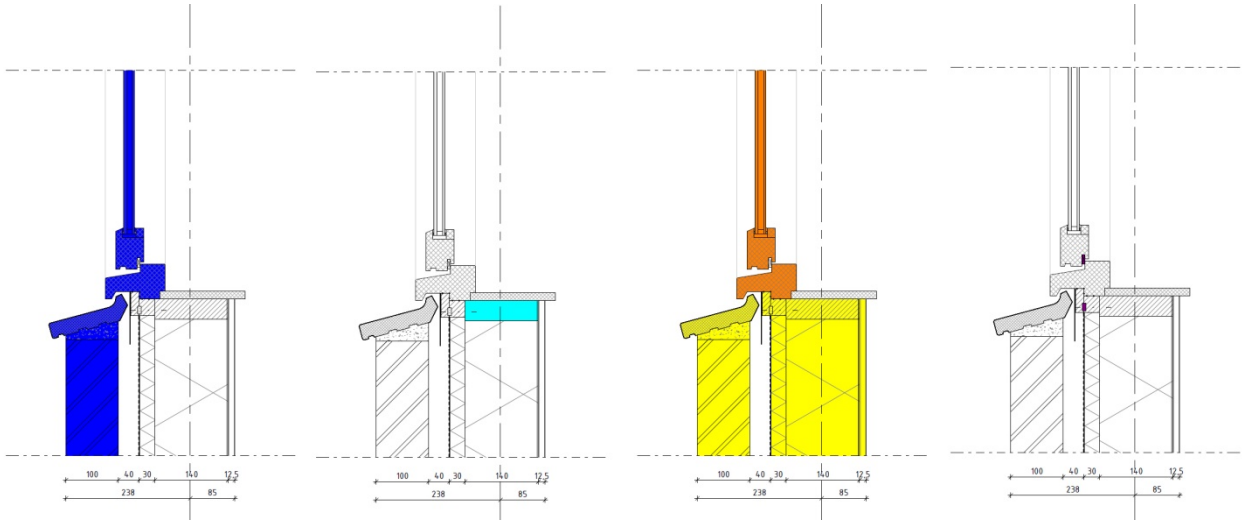
1. Qualification based Task Information Management

Definition

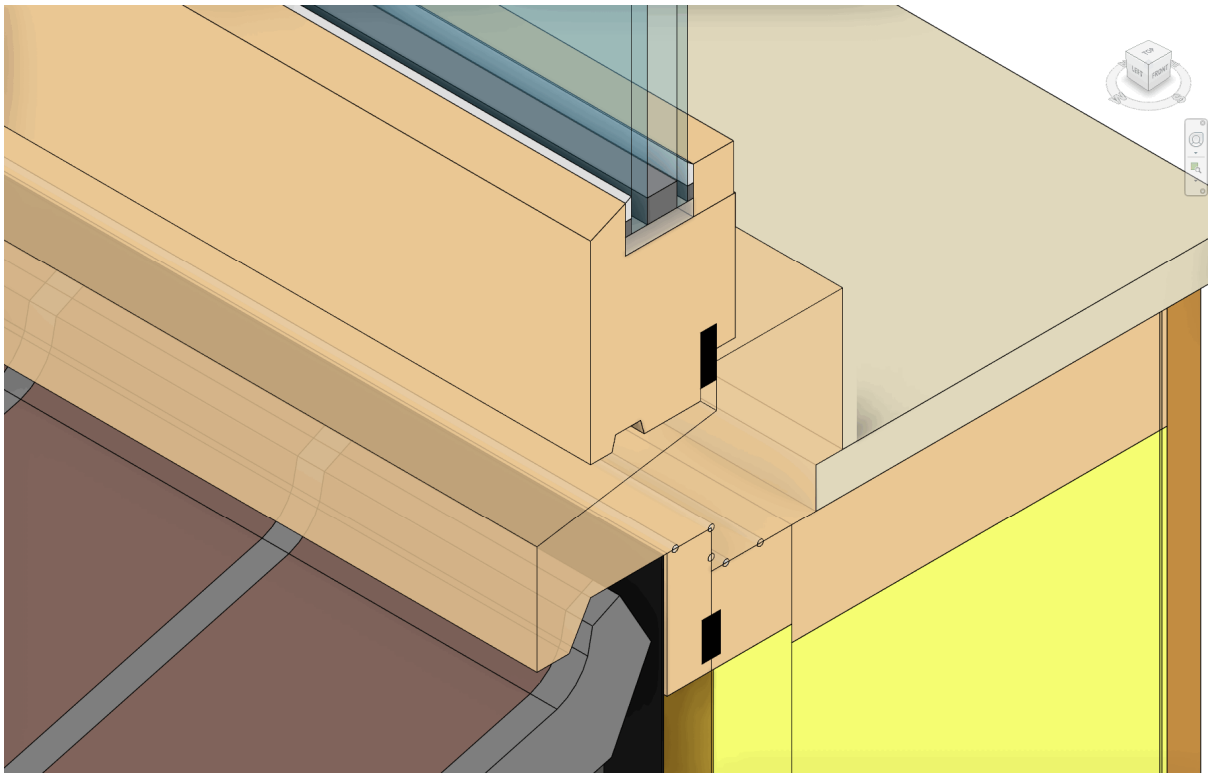
The pilot field lab will focus on making a step-by-step instruction manual for subcontractors with added qualification requirements per step. The information used for describing the steps will come from the project specific IFC model a/o reference details.

Approach

For 2 different weak spots – where the impact of field lab results will be biggest – reference details will be used/built.



Waterproofing Moistproofing Energetic prestation Airtightness



Example of a wooden frame reference detail (ISSO)

These reference details will be linked to the BIM-model or the BIM model will be setup to produce the details itself. The details will be put in a respective sequence to create an IKEA-like manual and assembly instructions will be added (along with do's and don'ts). The manual will be made project specific and also be comprised of the terms and conditions of inspection. Each step in the manual will also have qualifications added to them to help the subcontractors pick the right people for the job.

When a subcontractor starts his work he will be trained in the use of the manual and also in viewing the BIM model on site. The blue collar workers of the main contractor will have the same training.

Steps	What to describe	
Step 1	What tool will be used?	BIM-model with viewers Reference details Step-by-step instruction manual QF attached to BIM model and manual
Step 2	What will be tested?	Effectiveness of step-by-step instruction with project specific information Insight in subcontractor qualifications Effect on quality process and outcome
Step 3	What are the requirements for the BIM-model (and what adaptations are needed)?	Adding 4D (planning) parameters to objects in the reference details Adding qualification parameters to objects in the reference details
Step 4	What technical modifications or steps where needed?	Objects in the reference details need to be identified in the BIM model
Step 5	Is the solution tested usable for usage at the experimental sites	It is usable if the manual is short and simple

2. Blue collar feedback for model improvement

Definition

This pilot field lab concentrates on getting feedback (on the IFC model) from blue collar workers, so white collar workers can build better (i.e. usable) models. The impact on blue collar qualifications will also be measured.

Approach

The work process and information flow of blue collar workers (ventilation specialists) is analyzed, so their information input and output is known. This in- and output is compared to information stored in a/o attached to the IFC model and the blue collars qualifications (for BIM and ventilation). The quality of the model (in ways of delivering the right information to the right person in the right time) will then be analyzed to where there is too much or too little information in the IFC model. This analysis will be communicated with white collar workers to assess if and what improvements can be made in the modelling and information delivery.

Steps	What to describe	
Step 1	What tool will be used?	IFC model Viewers QF (3.3 and in-company)
Step 2	What will be tested?	If the information output of the model matched the required input by workers and in what way it helps them with improving their qualifications
Step 3	What are the requirements for the BIM-model (and what adaptations are needed)?	Ventilation systems need to be modelled Instructions need to be attached Adaptations are tested
Step 4	What technical modifications or steps where needed?	The information in the model needs to be filtered (in an aspect model or a basic ITO)
Step 5	Is the solution tested usable for usage at the experimental sites	The solution will be live (and concurrent) tested in an Experimental Site

3. The possibility of BIM-based inspection / linking inspection results to the IFC model

   Definition

   The pilot field lab will concentrate on what information (from BIM) is used in the quality process and how the results of quality control are fed back to the BIM model. The results should be a better understanding and view of the quality (QA and QC) processes and more accurate as-built information.

   Approach

   The inspection process (for airtightness) is analyzed on activities and information (what, who, when) and on what quality criteria are being used. This analysis is then mapped to information stored in the IFC model. This mapping also includes where the inspection results are linked (or stored) in the IFC model and when/what information from the IFC model is used for inspection. Based on blue collar qualifications, improvements in work processes will be researched (current qualifications vs. desired qualifications, and current information quality vs. desired information quality)

Steps	What to describe	
Step 1	What tool will be used?	Modelling software Viewers QA/QC software Checklists
Step 2	What will be tested?	The usability of the IFC model in the QA/QC process
Step 3	What are the requirements for the BIM-model (and what adaptations are needed)?	The IFC model must have the right parameters for quality checks and inspection results must be able to be linked to the IFC model

Step 4	What technical modifications or steps where needed?	Link between modelling software and QA/QC software
Step 5	Is the solution tested usable for usage at the experimental sites	It is usable if inspection data is linked to the IFC model and no data has to be entered twice

5. Results from Poland

5.1 Overview of methods to connect the selected tools and learning methods

As it is not common, that Client or Designers provide good BIM models, construction companies many times take responsibility on themselves to create them. Mostostal selected Autodesk Revit[1] as a software tool for BIM models creation. All workers involved in creation or editing BIM models, have to know how to work in Revit. For employees who are just starting their adventure with BIM, an online course is provided. An online training[2] includes 60 different topics and it is dedicated to BIM modellers at the construction site. In terms of the BIMplement project, special emphasis will be placed on:

- introduction to BIM,
- hierarchy of elements,
- modeling of windows and doors,
- roof modeling,
- punching,
- revision management,

The goal of this training is to ensure that people working on the site will be able to update the model to the most current state.

To guarantee the use of BIM models not only by the general contractor, but also by the client or designers, Common Data Environmental platform has to be implemented. Mostostal for two experimental sites selected BIM 360 Docs[3], where current documentation and models are stored. BIMplement trainers are responsible for conducting training on platform operation for the present and future users.

Blue collar workers will have a possibility to browse models on a computer or tablet and discuss problematic issues with construction supervision. Special training about different viewers[4] will be conducted by BIMplement workplacetrainers, however BIM Coordinator on site will be responsible for delivering the most actual model.

White collar workers will be trained from Navisworks[5] to ba able carry out collision analyzes at the construction site. Additionally, the worker responsibible for scheduling, will be trained how to combine planning with the 3d model. Visualisation of planned work should help to better understand the work sequences by employees. Synchro PRO[6] software will be a tool dedicated for creating 4D BIM models.

The construction supervisors will be equipped with mobile application for collecting information about completed works and quality checklist lists. This application will be created in PowerApps[7] and will be tested in Pilot field labs for better adaptation to the construction needs.

[1] https://www.autodesk.co.uk/products/revit/architecture
[2] https://www.cadach.pl/e-szkolenia,3.html
[3] https://bim360.autodesk.com/
[4] https://bimvision.eu/en/about/
[5] https://www.autodesk.com/products/navisworks/overview
[6] https://www.synchroltd.com/products-2/synchro-scheduler/
[7] https://powerapps.microsoft.com/en-us/build-powerapps/

5.2 Experiments in the Pilot Field labs

Each experimental site will also serve as a pilot field lab where white and blue collar workers will be trained. The BIM tools before implementation on site will be tested in Pilot Field Labs.

Steps	What to describe	
Step 1	What tool will be used?	BIM models and viewers, Navisworks manage, BIM Vision, Mobile applications, Synchro PRO
Step 2	What will be tested?	Clash detection, visualization for blue collar workers, checklists, planning visualization
Step 3	What are the requirements for the BIM-model (and what adaptations are needed)?	Requirements for correct modeling An experienced person who will implement the information needed to the model.
Step 4	What technical modifications or steps where needed?	Analysis of places where problems with airtightness can occur
Step 5	Is the solution tested usable for usage at the experimental sites	After tests and acceptance by the construction manager

6. Results from Spain

6.1 Overview of methods to connect the selected tools and learning methods

Two main methods will be experimented in Spain. They both will be implemented through specifically design training sessions for white and blue collar workers:
1) related to improve knowledge and acquire skills for proper ventilation and airtightness
2) related to train in BIM methodology for a useful model in all stages of the project

In addition a research pilot field lab will be developed to link technical information to the BIM model.

6.2 Experiments in the Pilot Field labs

1 Improve knowledge and acquire skills for proper ventilation and airtightness

Specifically design training sessions for white and blue-collar workers will be organized. The content of these courses will be both theoretical and practical. Different groups of potential participants are identified, for instance: the architects who design, the construction company and the installers.

Each of these groups requires a different training. Specific theoretical contents will be developed but also didactic material available in open format will be reused (see D3.2).

For a more practical approach to the placement of the solutions and construction systems, mock-ups will be requested from the manufacturing companies (such as SIBER for ventilation and SIKA for airtightness). This way the trainees will be able to experiment and manipulate the materials, which favors a more dynamic and participative training.

Quality control concepts that ensure proper ventilation and air tightness of the building will be introduced. Tests will also be carried out, such as Blower Door.

Steps	What to describe	
Step 1	What tool will be used?	Teaching material (notes, related bibliography, links of interest, catalogs of solutions, etc.) Mock-ups
Step 2	What will be tested?	Practical approach to the placement of the solutions and construction systems through mock-ups.
Step 3	What are the requirements for the BIM-model (and what adaptations are needed)?	All weak points in terms of airtightness and ventilation have to be identified.
Step 4	What technical modifications or steps where needed?	A physical space to locate mock-ups and people attending the lessons. A virtual platform for online contents
Step 5	Is the solution tested usable for usage at the experimental sites	Yes, mock-ups can be moved to the experimental site.

2 Training in BIM methodology for a useful model in all stages of the project

The BIM methodology is more implemented in the design phase than in the construction phase. The "as built" model cases are increasing in the use and maintenance stage of the building. The use of the BIM model by installers is practically non-existent at present.

The harmonization of a BIM model that works effectively in the different phases of the project is necessary. This work of harmonization corresponds to the Administration. The conclusions of the BIMplement project are of interest to the regional and state Government as guidance when laying a methodological basis.

It is necessary to organize a participatory session attended by all agents of all phases to know the needs of each agent and obstacles that are found in order to use the same BIM model. It is important to have a unique and useful BIM model throughout all the stages of the project (design, construction and maintenance).

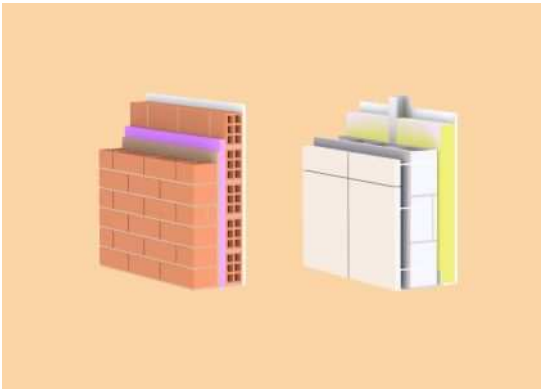
Then the workers will be trained differently, the white-collar workers will need more knowledge in the design of the BIM model adapted to the needs that the construction company will have in the construction phase, and the blue-collar workers will need to visualize and understand the BIM model they receive from the designers to faithfully follow the indications received.

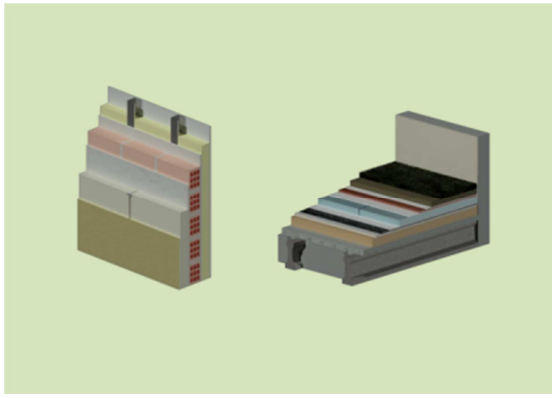
Steps	What to describe	
Step 1	What tool will be used?	CYPE software (or similar) for modelling in BIM. BIM model freeware viewers.
Step 2	What will be tested?	The participatory session (collaborative workshop).
Step 3	What are the requirements for the BIM-model (and what adaptations are needed)?	All the agents participating in the project must be convinced to use the BIM model in all phases. The BIM model should be useful and include the necessary data for all phases, including the construction phase and the maintenance phase. It is necessary to guarantee the continuity of the BIM model.
Step 4	What technical modifications or steps where needed?	The BIM model has to be changed in line with the data missed and needed by other agents in the chain. It is important to have a unique and useful BIM model.
Step 5	Is the solution tested usable for usage at the experimental sites	No specifically for the experimental sites but the conclusions of the BIMplement project will be discussed with the local and national Administration as they can be interesting to establish first steps in the harmonization of a BIM model.

3 Link technical information to the BIM model

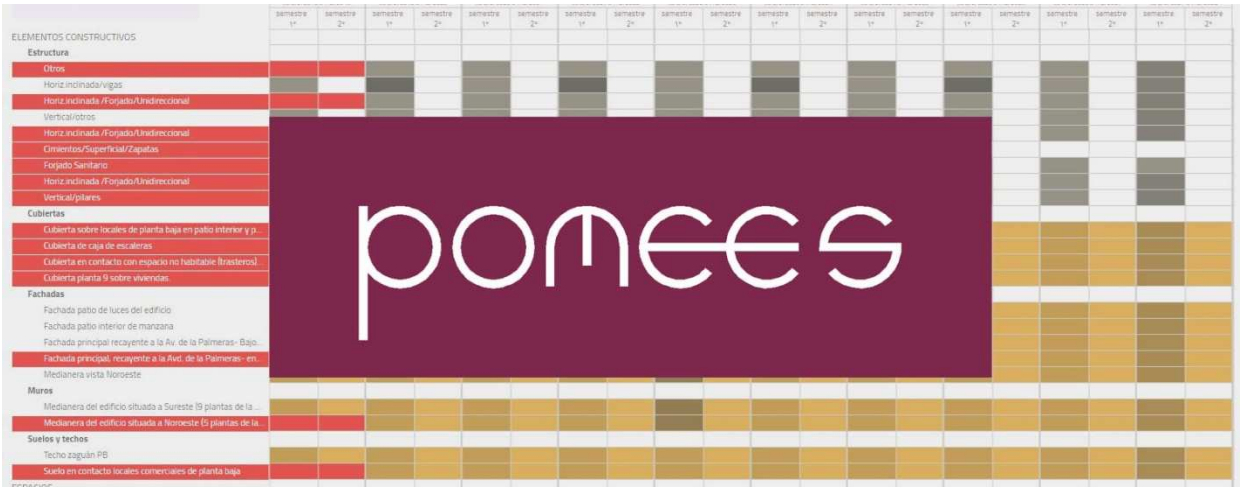
IVE has material with relevant information on issues of ventilation and air tightness. This material is considered official since it has been approved by the regional Administration. The challenge would be to link the available information to the BIM model. This would complete the information already available and give an added value to the material developed. More specifically this material consists of:

- BUILDING CONSTRUCTION BOOKLETS: These booklets are simple and easy to carry documents. They contain work procedures designed to support operators and construction managers during the construction phase. Currently there are 8 booklets for renovation works (+ info), 13 booklets for construction of new facades (+ info) and 10 booklets for construction of new roofs (+ info).





- POMEES - Maintenance Operations Program in Existing Buildings (+ info): It is a computer program that creates editable files with the operations of use and maintenance that must be done in each element of the building during the next 50 years.



- TECHNICAL CONDITIONS DOCUMENT (+ info): This document contains the conditions that the project is ordered to comply with in the execution of the work. It concerns the developer (as a contractual document), the builder (as a document that collects the orders given from the project for the correct execution) and the director of the work (as a compilation document of the execution conditions of the projected work).

In relation to air tightness, it is not easy to link BIM information. One option would be to link the BIM information to several elements (windows, doors, chimneys, etc.). Another option would be to link the BIM information in a general way as a project specification.

Steps	What to describe	
Step 1	What tool will be used?	BIM software Building construction booklets POMEES – Maintenance Operations Program in Existing Buildings Technical conditions document
Step 2	What will be tested?	Capacity of attaching documents to the BIM model
Step 3	What are the requirements for the BIM-model (and what adaptations are needed)?	Adapt this material to the BIM model
Step 4	What technical modifications or steps where needed?	The necessary information must be identified to adapt these tools to the BIM model
Step 5	Is the solution tested usable for usage at the experimental sites	Yes, it is usable for example: Building construction booklets will be linked to BIM objects and blue collars will be able to visualize graphic details to implement properly ventilation and air tightness solutions.

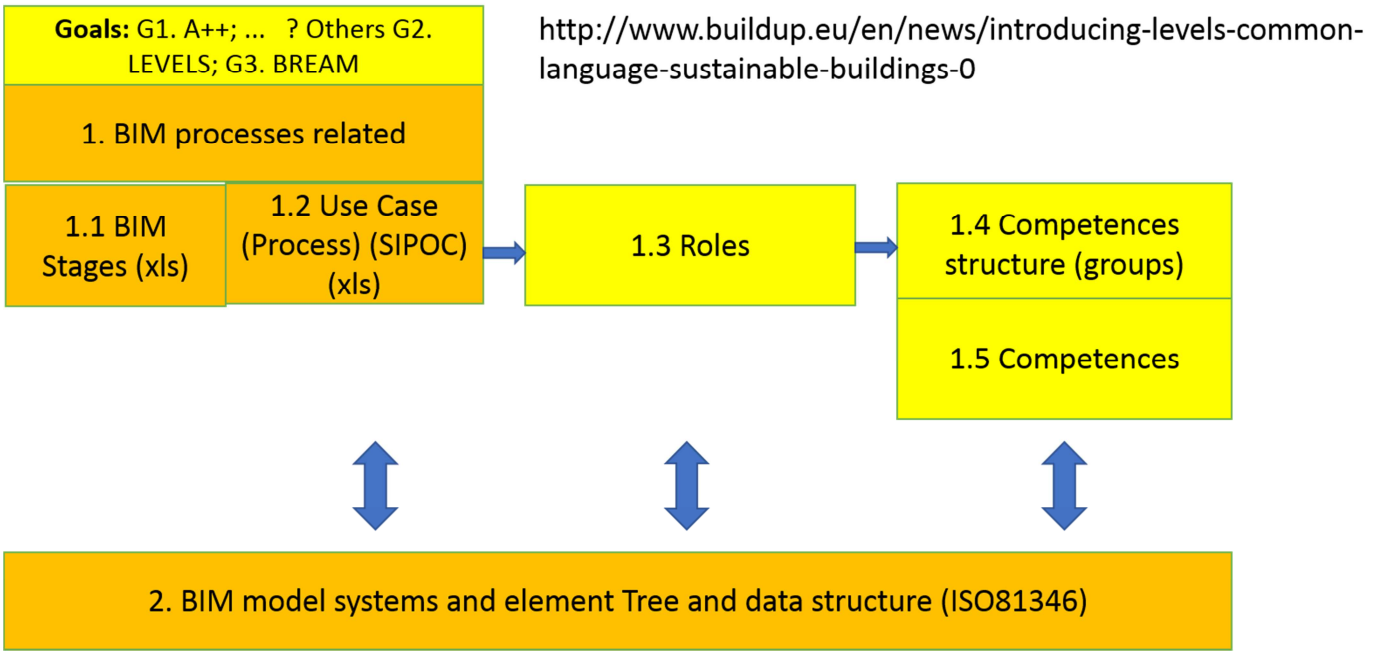
7. Results from Lithuania

7.1 Overview of methods to connect the selected tools and learning methods

Based on some years of findings of open national BIM initiative Digital Construction (DIGCON) in relation to competences model structure development, one BIM competence model could be developed at national level for New and Refurbishment projects with only few important differences in the Use Cases.

The figure below presents suggested approach for DIGCON (national open BIM initiative) BIMPlement Competences scope within BIM (project management processes) and NZEB related content (construction technologies, eg, Ventilation and Airtightness) that will be tested during the BIMplement project.

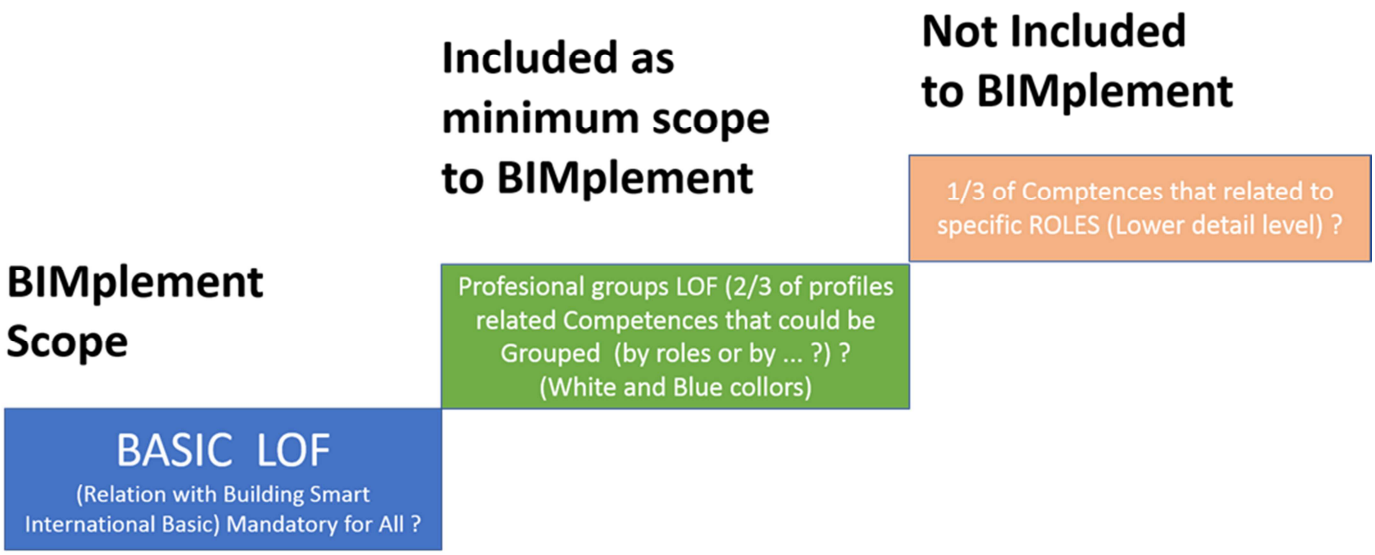
SCOPE: BIM (Processes) + Energy efficiency (Not versus) + Other KPI



The main principles for competence model development will include:

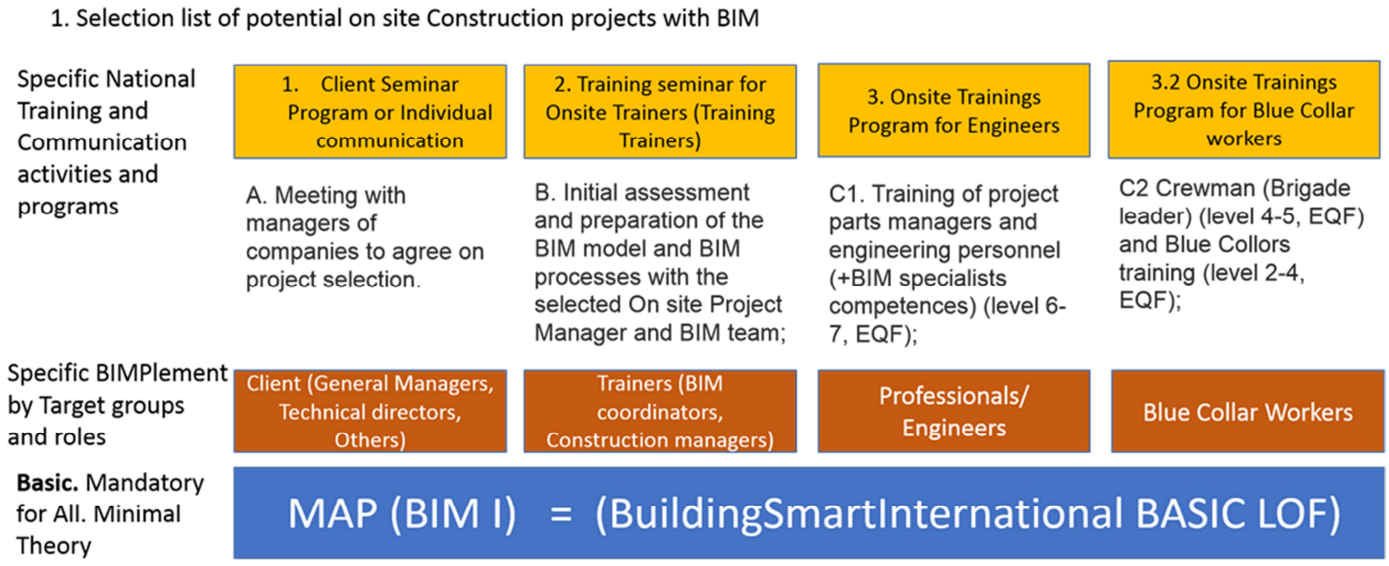
1. Clear definition of Goals;
2. Some of Sustainability methodologies should be incorporated to the model (for example: LEVELS: http://www.buildup.eu/en/news/introducing-levels-common-language-sustainable-buildings-0
3. Interchange between existing and new roles:
    - New BIM related roles appeared within existing Buildings Design, Construction and Maintenance structure (BIM Coordinator, BIM Manager and others);
    - Existing roles that need upgrade their competences in the area of BIM related changes (processes, technologies);
    - It is important to ensure DIGCON LOF integration with Building Smart International Qualification model.

Suggested BIMplement Learning outcomes Framework (LOF) scope

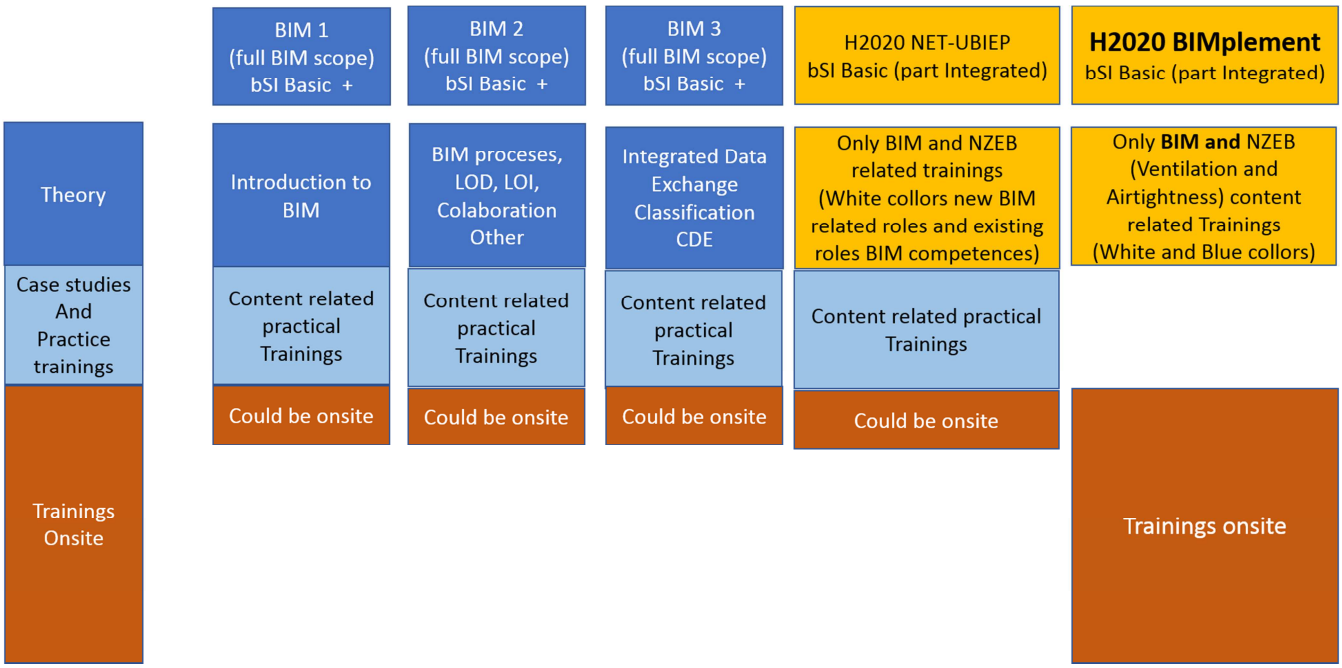


The figure below presents an approach that will be tested at national level, while using BIMplement methodology first at Field labs (the first experimental sites acting as a Field labs), then moving towards other selected experimental sites. The initial training would be undertaken by using Digital Construction (national open BIM initiative) facilities (Training Class).

BIMplement training (On site approach)



The training structure, process and content will be closely integrated with national open BIM initiative, other national and international initiatives (eg. H2020 NET-UBIEP) as illustrated in the figure below. Relations between DIGCON.LT BIM training programs (Integration with STATREG.lt (LT case)



Selected learning tools for BIMplement (National level, Lithuania):

- For BIM methodology: www.digitalconstruction.lt / Documents EIR, BEP, Stages and Usecases; LOD descriptions.
- For Construction technologies: www.statybostaisykles.lt (Construction technologies descriptions, quality check lists, competences requirements, certification test questionnaires)
- For BIM classification: http://ics.infinibim.com/ (part of BIMaxon system)

  user: bimplement@bimplement.com
- DIGCON (LT) Competences register (National level): www.STATREG.lt
- For BIM data management (asbuilt part): BIMaxon
- Electronic construction works journal (http://statyboszurnalas.lt/) as a an information system for filling and storing construction documents that brings together all construction actors will be used as a part of quality training.

7.2 Experiments in the Pilot Field labs

1. enriching BIM-models with BIMplement QF and training content.

Project partners in Lithuania will extensively use results of the project, especially results produced in WP 3 and 4. National (Lithuania) cloud-based construction classification system, http://ics.infinibim.com/ will serve as a foundation and will be used for implementation of BIMplement competence model in Lithuania aligned with other competence models related with BIM and nZEB. Classification structure will include construction project stages, use cases (management processes), BIM model functional and technical systems, elements, construction technology processes, actors, competences, skills, knowledge, and other structure components.

For the presentation of BIM model BIMAXON and other BIM model development, simulation, co-ordination, visualization software will be used for different use cases. Initial list of different BIM Viewers common in Lithuania is provided below:

1. TeklaBIMSight;

2. Solibri Viewer;

3. Naviswork Freedom;

4. Autodesk Design Review;

5. Bentley Navigator

Cloud based:

1. Autodesk A360

2. BIM+

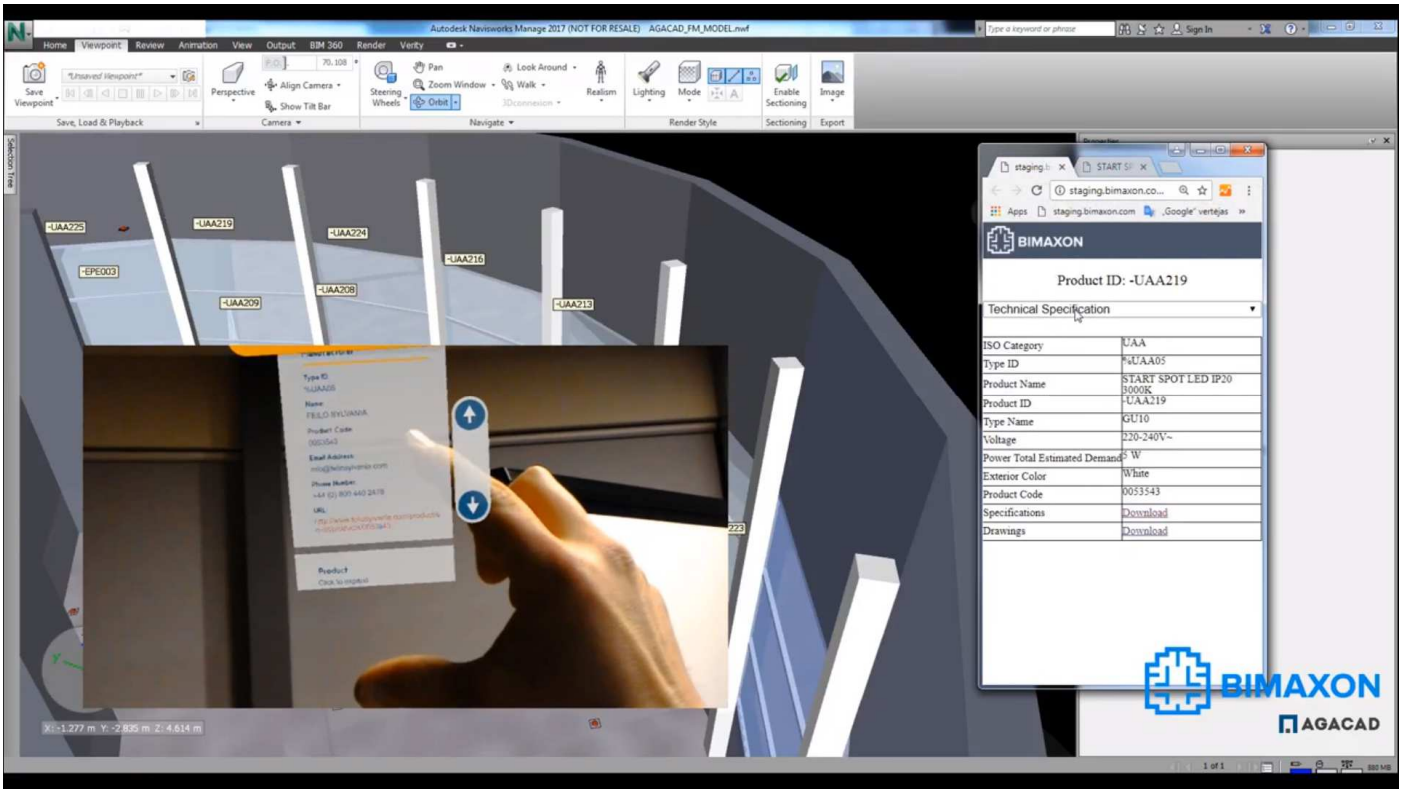
Knowledge of BIM solution providers (like AGA CAD, www.aga-cad.com) will be used to ensure a proper market and technology knowledge to the companies that will participate in the project and provide pilot sites.

The following workflow will be tested:

1. 3D Laser Scanning
2. Modeling in Revit
3. Sync with BIMAXON CDE in Navisworks
4. Sync with MS SharePoint in BIMAXON WEB
5. Asset management in SharePoint Online (Included in Office 365 package)
6. Asset analysis in SmartPhone and MS HoloLens

The same workflow is for New BIM projects except 1st task (3D Laser Scanning).

Here is a video of BIMAXON. https://youtu.be/WvwB7Z4UXns


BIMAXON
Product ID: -UAA219
Technical Specification
ISO Category UAA
Type ID %UAA05
Product Name START SPOT LED IP20 3000K
Product ID -UAA219
Type Name GU10
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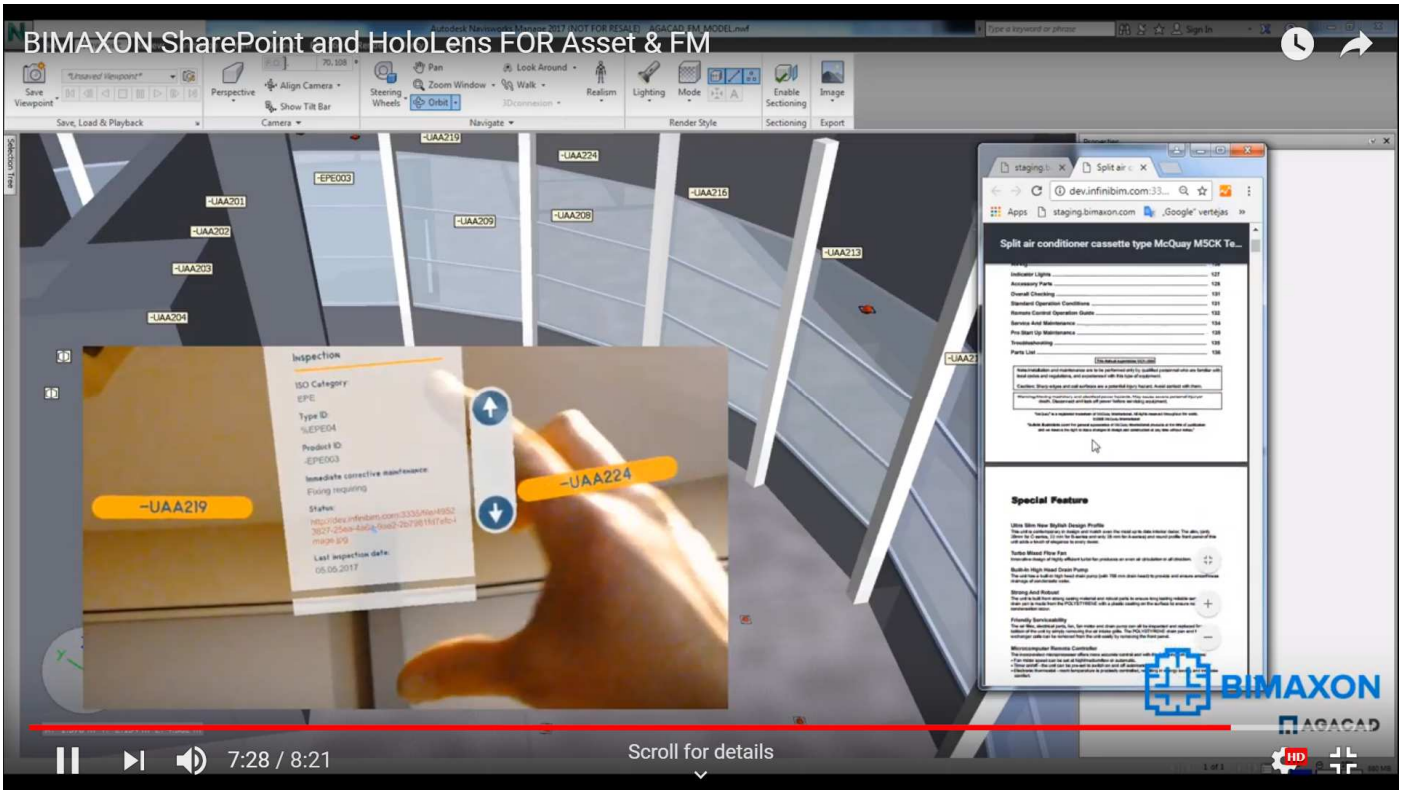
BIMAXON SharePoint and HoloLens FOR Asset & FM
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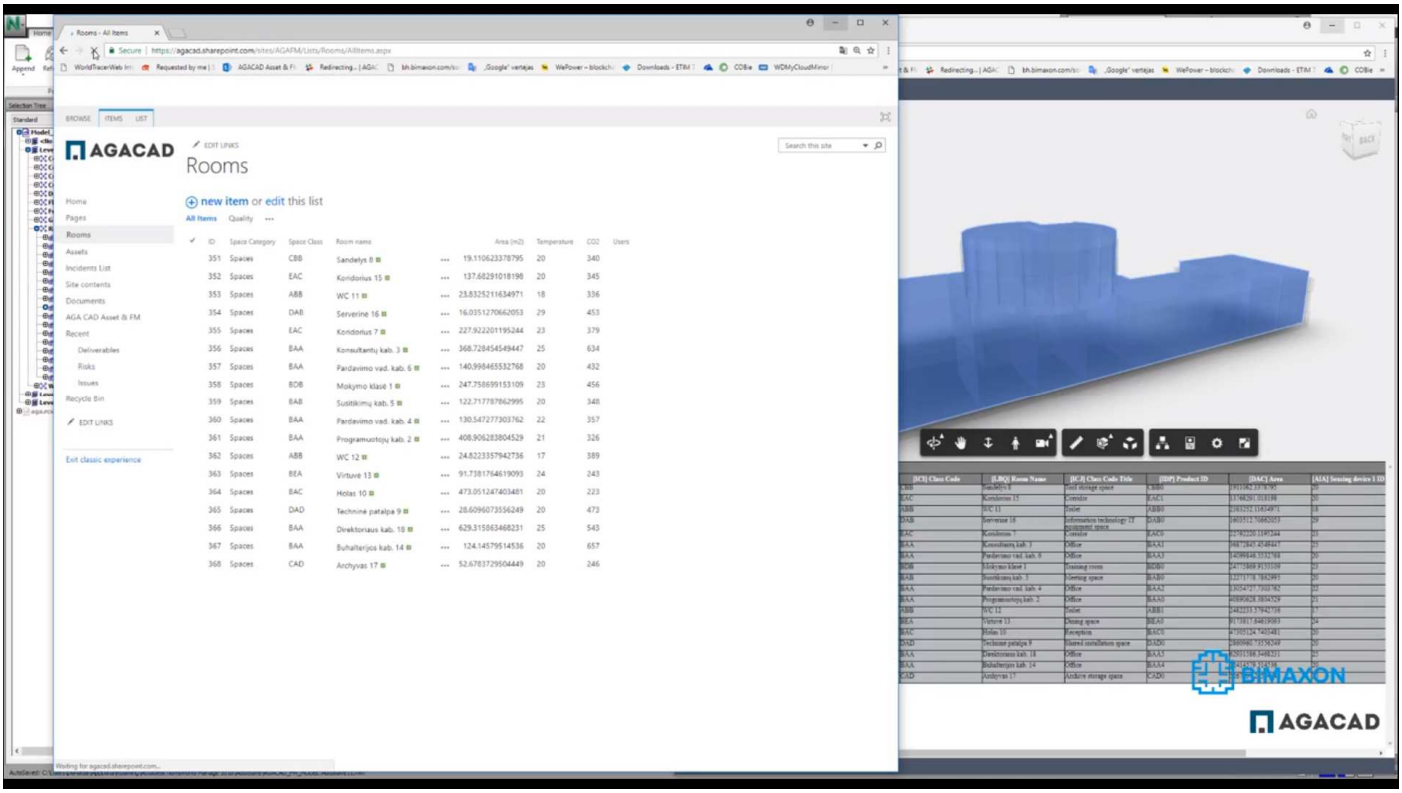

Steps	What to describe	
Step 1	What tool will be used?	For the presentation of BIM model BIMAXON.ICS information classification system and other BIM model development, simulation, co-ordination, visualization software will be used for different use cases. Initial list of different BIM Viewers common in Lithuania is provided below: 1. TeklaBIMSight; 2. Solibri Viewer; 3. Naviswork Freedom; 4. Autodesk Design Review; 5. Bentley Navigator Cloud based: 1. Autodesk A360 2. BIM+ 3. Others already selected from the Contractors and used as usual in their businesses
Step 2	What will be tested?	Effectiveness, quality issues, subcontractor qualifications Information visualization for blue collar workers, checklists, planning visualization and other Use cases depending on BIM maturity level of the company. Employes Information requirements

Step 3	What are the requirements for the BIM-model (and what adaptations are needed)?	BIM 3D (Geometry part) Information Data setup: • Rational amount of data direct in 3D model part; • BIM systems and elements references to external information DB (data base based) • BIM systems and elements references to external information DB (file based) • Development of Documentation (If needed)
Step 4	What technical modifications or steps where needed?	Objects in the reference details need to be identified in the BIM model and tested in different CDE environments and different projects maturity levels. Test of initial set BIMPlement related project stages and Use cases; Test of different CDE (Common data environment) and different technologies depending of contractors maturity levels
Step 5	Is the solution tested usable for usage at the experimental sites	The solution is applicable in the experimental sites but will differ depending from contractors' BIM maturity level and projects BIM and NZEB goals.

2. The use an an Electronic construction works journal

Electronic construction works journal (http://statyboszurnalas.lt/) as a an information system for filling and storing construction documents that brings together all construction actors will be used as a part of quality training. The training will introduce the preparation of the technical design documentation, the Structural Elements, the Volume Lists, the begining of the filling of the Journal: Records, attachments (material declarations (passports), drawings, photographs), electronic signature procedures.

Steps	What to describe	
Step 1	What tool will be used?	Digital construction works journal www.StatybosZurnalas.lt
Step 2	What will be tested?	Quality requirements, processes
Step 3	What are the requirements for the BIM-model (and what adaptations are needed)?	Alignment with the classification system
Step 4	What technical modifications or steps where needed?	The system is usable at the some experimental sites, were Contractors have decided to use this solution. It allows to store records of ongoing work in a standardized, expeditious, transparent and secure manner; it enables managed access to information related to the site; ensures the legitimacy of the

		construction process, participants and records.
Step 5	Is the solution tested usable for usage at the experimental sites	

COLOFON

BIMplement

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The information in this publication does not necessarily represent the view of the European Commission.